EIGHTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1915-1916

SUPPLEMENT TO THE REPORT OF
THE DEPARTMENT OF AGRICULTURE

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1916

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Quebec Society for the Protection of Plants from Insects and Fungous Diseases

1915-1916.

To the Honourable J. E. Caron, M. P. P.,
Minister of Agriculture,
Quebec.

Sir:—

I have the honour to present herewith the Eight Annual Report of the Quebec Society for the Protection of Plants from Insects and Fungous Diseases, containing proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 14th of March, 1916.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

J. M. SWAINE,
Secretary-Treasurer.

Ottawa,
1916.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

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President—Professor Lochhead, Macdonald College.

Vice-President—Mr. Auguste Dupuis, Director of Fruit Experiment Stations, Village des Aulnaies, P.Q.

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Delegate to the Royal Society of Canada—Prof. Lochhead, Macdonald College.

Delegates to the Ontario Entomological Society—Mr. J. C. Chapais, St. Denis, Que., and Father Leopold, La Trappe.

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Hewitt, Dr. C. G. ..... Entomological Branch, Ottawa
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Reid, B. T.....Woodstock, N.B.
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Swaine, J. M.....Dept. of Agr., Ottawa
Vanderleck, J.....Macdonald College
Victorin, Rev. Bro.....Longueuil, Que.
Winn, A. F.....32 Springfield Ave., Westmount

HONORARY MEMBER:

James W. Robertson, Esq., LL.D., C.M.G.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS FROM INSECTS AND FUNGOUS DISEASES, 1915-1916

Receipts

Brought forward	$ 296 61
Provincial Government cheque	250 00
Interest on Deposit to Dec. 31, 1915	4 87
	$ 551 48

Disbursements

Expenses of members and the evening lecturer to the meeting	$ 42 00
Expenses of the delegate to the meeting of the Ontario Ent. Soc. at Toronto	28 15
Society paper and envelopes	15 50
Postage and express in connection with distribution of reports	19 25
Secretary's Stipend	50 00
Cost of Printing separates from the report, Eng. Ed.	21 10
Balance cash on hand	375 58
	$ 551 48

J. M. SWAINE, Secretary-treasurer.

WM. LOCHHEAD, President.

Auditor:—

E. M. DUPORTE

EIGHTH ANNUAL REPORT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

Report of the Winter Meeting

The Eighth Annual Meeting of the Quebec Society for the Protection of Plants was held at Macdonald College on March 14th, 1916. The opening business meeting was called to order by the President, Professor Lochhead, at 2 p.m. There were present: Professor Lochhead, Macdonald College; J. C. Chapais, St. Denis-en-bas; Father Leopold, La Trappe; Father Fontanel, St. Mary's College, Montreal; A. Gibson, and J. M. Swaine of the Entomological Branch, Ottawa; W. A. McCubbin, Division of Botany, stationed at St. Catharines, Ont.; P. I. Bryce and E. M. Duporte of Macdonald College.

The minutes of the last meeting, March 11th, 1915, were read and approved.

Letters of regret for inability to attend the meeting were received from Rev. Dr. Fyles, Ottawa, and Rev. Bro. Victorin, Longueuil.

The Report of the treasurer was read and accepted.

The president reported on the progress since the last meeting of the scheme for the publication of a new Flora of the Province of Quebec. The attention of the members was directed to the list of Diptera of the Province of Quebec by Winn and Beaulieu, published as a supplement to the 7th report of the Society.

The President also reported that a list of Coleoptera of the Province of Quebec, prepared by Mr. G. Chagnon of Montreal, was practically ready for publication. Mr. Chagnon's list was presented at the meeting and it was decided to publish it as a supplement to the English report.

It was resolved that the usual grant be made available from the Society's funds for expenses in connection with special investigations of insects and fungous diseases in the Province, and for any expenses in connection with the preparation of the list of insects.

The publication of a preliminary list of injurious fungi of the Province of Quebec was discussed in detail. It was pointed out that the active work would have to be done very largely by Professor Fraser of Macdonald College. The following committee was formed to assist in the preparation of such a list, Professor Lochhead, Rev. Dr. Campbell, Montreal, Professor Fraser, and J. M. Swaine.

It was decided to hold the summer meeting of the Society at La Trappe, Que., in September, in conjunction with the Quebec Pomological Society, the date of the meeting to be announced later by the secretary.

The following officers were elected for the ensuing year:—

PRESIDENT—Professor W. Lochhead, Macdonald College.

VICE-PRESIDENT—Mr. Auguste Dupuis, Director of Fruit Experiment Stations, Village des Aulnaies, Que.

SECRETARY-TREASURER—Mr. J. M. Swaine, Assistant Entomologist for Forest Insects, Entomological Branch, Ottawa.

CURATOR AND LIBRARIAN—P. I. Bryce, assistant in Biology, Macdonald College.

DIRECTORS—Rev. Dr. Thomas Fyles, Ottawa; Father Leopold, La Trappe; Bro. Victorin, Longueuil; Prof. Fontanel, Montreal; Abbé Huard, Quebec; Messrs. A. F. Winn, Montreal; G. Chagnon, Montreal; W. P. Fraser, Macdonald College; G. Bouchard, Ste. Anne de la Pocatière.

AUDITORS—E. M. DuPorte, Dr. Hamilton, Macdonald College.

DELEGATE TO THE ROYAL SOCIETY OF CANADA—Professor Lochhead.

DELEGATES TO THE ONTARIO ENTOMOLOGICAL SOCIETY—Mr. J. C. Chapais, Father Leopold.

GENERAL SESSION

The General Session of the Eighth Annual Meeting of the Quebec Society for the Protection of Plants was opened at 3 p.m. in the Biology Building of Macdonald College. There was a large attendance of delegates, among whom were Dr. R. Matheson of Cornell University; Messrs. J. C. Chapais, St. Denis-en-bas; G. Bouchard, Ste. Anne de la Pocatière; Father Leopold, Professor Letourneau, Mr. H. B. Roy and Bro. Benjamin of Oka Agricultural Institute; Messrs. A. Gibson and J. M. Swaine of the Entomological Branch, Ottawa; Messrs. W. A.McCubbin and P. Cowan of the Botanical Division, Central Experimental Farm; A F. Winn, G. A. Moore, Lachlin Gibb, J. G. Holmes and Mr. Southie of the Montreal Branch; Rev. Dr. Corcoran of Loyola College; Fathers Fontanel and Goucie of St. Mary's College.

A large number of members of the staff and students of Macdonald College were present at both sessions.

The following resolutions were passed at the meetings:—

Resolution 1.

That on account of the great damage done to orchards by various canker diseases it is necessary that a study of these cankers be made at once. The Society asks that the Provincial Department of Agriculture take the necessary steps to appoint an expert on this work.

Resolution 2.

The Society places on record its appreciation of the great work of the late Henri Fabre, the eminent entomologist of France, who died October 11th, 1915. His great work "Les Souvenirs Entomologiques" will for all time be an inspiration to workers among insects.

At the general meeting at which the president, Professor Lochhead presided, Dr. Harrison welcomed the delegates and hoped that the meeting would be a very successful one. He congratulated the province on having such a society within its borders on account of the excellent work it was doing. Father Leopold gave an account of the proceedings of the annual meeting of the Ontario Entomological Society at Ottawa last November. Mr. A. Gibson of the Entomological Branch, Ottawa, described clearly the work of the Entomological Branch with its field stations in the different provinces. He also described the experiments carried on under his supervision for the control of grasshoppers during the past two seasons. Mr. E. M. Duporte of Macdonald College gave an account of the injurious insects of the season 1915. Mr. W. A. McCubbin, located at the field station at St. Catharines, gave a very interesting and timely address on the Pine Blister Rust in Ontario, a disease which attacks the white pine. The alternate hosts for this rust are currant and gooseberry. He threw out a warning to Quebec that incipient outbreaks of this rust should at once be stamped out. Mr. J. C. Chapais read one of his delightful popular papers on Chrysopa or Golden Eyes. Father Leopold on behalf of Professor Letourneau read a most interesting and valuable paper on Pear or Twig Blight, a disease which is doing considerable damage in the orchards of this province. Mr. Cowan of the Botanical Division, Ottawa, read a paper on "Some Potato Problems," in which he discussed the various potato diseases. Father Fontanel of St. Mary's College, Montreal, read a very interesting paper

entitled "The Active Army in the Fields and Instruction in Books," in which he made suggestions as to how the work of nature study might be fostered in the schools. He said it was very essential that the pupils should be acquainted with the common things in order that they might be able to understand them when they came to deal with them in practical work on the farms.

At the evening session the president, Professor Lochhead, read a paper entitled "Some Aspects of Insect Behaviour," and Dr. Matheson of Cornell gave a valuable illustrated address on "Apple Plant Lice and their Control." Dr. Matheson discussed the three common species of plant lice and described the resemblances and differences in their life history and powers of production. H. B. Roy, of the Oka Agricultural Institute, in a very interesting illustrated address described the injurious effect of smelter fumes on vegetation in the Sudbury district. It was very clear from the slides and his descriptions that the farmers of that district suffer very severe losess on account of the poisonous fumes given off from the smelters.

The attendance of regular members was between 40 and 50, the largest in the history of the Society.

PRESIDENT'S ADDRESS

SOME ASPECTS OF INSECT BEHAVIOUR

W. Lochhead, Macdonald College.

I.—INSTINCT.

With the more intensive study of economic entomology that characterizes the activities of present-day workers, considerable attention is being given to Insect Behaviour in its widest sense—their behaviour towards stimuli of various kinds such as temperature, light, moisture, and chemicals, including poisons; their behaviour towards one another, etc., etc.

The writer recognizes at the outset the difficult nature of the subject, also his own inability to discuss it adequately, but he thought that even an imperfect discussion such as his might serve a useful purpose in directing attention to this most interesting phase of insect life.

Instinct and Intelligence.

It is customary to classify behavior actions into *instinctive* and *intelligent.* Among the lower animals actions are predominantly instinctive, while in the higher animals intelligence counts for more than instinct. A difficulty arises, however, in defining instinct and in determining its origin. Some authorities believe that instinct cannot be separated from intelligence, that it represents "lapsed intelligence" inasmuch as it is the inherited result of experiences which showed first as habits and later as instinct. This view was held by Spencer, Haeckel, Wundt, and others, but under the influence of Weismannism it has been to a large extent abandoned, and other views have been put forward. Some regard instinctive actions as a series of reflexes linked together, "whereby certain hereditary dispositions of awareness of certain things are linked with hereditary dispositions to follow a certain routine." Loeb, Bohn and others believe that instincts are *tropisms* or a combination of *tropisms.* They maintain that instinctive behaviour is determined by the mechanical reaction of the organism to such stimuli as light, heat, moisture, etc. Many interesting observations on tropic reactions of insects have been recorded in recent years, and the study of reflexes and reflex actions has been raised to a higher level than formerly.

Tropisms.

For some time it has been known that plants show tropistic movements with regard to light, heat, gravity, moisture, contact, etc. Moreover, some progress has been made towards an understanding of the processes. Plants, for example, bend toward the light because the cells on the side away from the light grow faster than those on the side next the light. There is no conscious control of the movement by the plant. Animals, too, exhibit movements under the influence of tropic stimuli. In the case of insects, butterflies, bees, house flies, and many moths and caterpillars are positively phototropic, and move towards the light, while maggots, bed bugs and cockroaches move away from the light.

Again, most moths move away from sunlight but move towards a lesser light such as electric or oil lamps. Davenport explains this difference by saying that "butterflies are attuned to a high intensity of light, moths to a low intensity." Loeb explains the circling of moths and other insects about a light. The stimulus orients the insect by its more intense action on the muscles next the light, and the insect then moves towards the light.

Loeb states that caterpillars of the Brown Tail Moth as they emerge from hibernation in spring are positively phototropic, but after they have

eaten this response disappears, showing that tropism reactions are sometimes dependent on the state of the body.

Mr. Strickland of the Entomological Branch, Ottawa, observed during the outbreak of the Western Cutworm *Chorizagrotis auxiliaris* and *Porosagrotis orthogonia* in Alberta in 1914-1915, that their movement in army-worm fashion was always in a definite direction—northwesterly—in response to a phototropic stimulus.

Some insects respond to the stimulus of touch or contact, and are said to be either positively or negatively thigmotropic. Cockroaches are in the habit of squeezing into narrow crevices, and Loeb mentions the case of a moth Pyrophila which also has the same habit.

Chemical substances and foods also act as stimuli influencing the movements of insects. Maggots orient themselves with regard to their food and then move toward it, the orientation being the result of unequal chemical stimulation of the muscles of the two sides of the body. The deposition of eggs by most insects on certain plants is also the result of chemotropism.

Wheeler and Loeb give several examples of geotropism among insects. They observed that lady-birds and cockroaches at rest placed themselves on vertical rather than horizontal surfaces.

Observations show that tropic reactions are very adaptive. Ants and aphids are positively phototropic when they get wings; and honey bees are periodically phototropic, thus leading to swarming. Ants, moreover, are strongly thermotropic, thus securing for their brood the optimum temperature conditions.

While tropic reactions are adaptive they are not always beneficial. For example, moths are attracted to the flame and are killed, and many insects in following the stimulus become a prey to their enemies.

Death-Feigning Reactions.

Mention should be made here of a valuable study of *Death Feigning Reactions in Tychius picirostris* by Mr. E. M. DuPorte of the Biology Department of Macdonald College. An account of the study appears in the current number of the "Journal of Animal Behaviour." This death-feigning habit is quite common among insects, and scientists are not agreed as to the meaning of it.

Mr. DuPorte shows that intensity of shock has no effect on the production or duration of the death-feint; that the duration of the feint is variable

and that the number of feints produced by repeated stimulations is not indefinite. After a period of rest the insect recovers to a certain extent and reacts to shock.

When the insect in the death feint is mutilated by the removal of legs and antennae it still remains quiescent, and on recovery can be made to feint again. On the other hand removal of the tip of the abdomen or division of the body in the thorax or between the thorax and the abdomen brings the insect out of the feint. When insects in feint are placed on iron plates lightly warmed they become active, and the feint is not produced by dropping the insect on a hot plate, but is readily produced when it is dropped on a plate slightly above the temperature of the room.

Feinting is readily induced at a temperature of 11°C. and its duration is much longer. Cold alone, without shock, produces death feint.

When insects in feint were introduced into vapor of chloroform, difficulty was found in getting them to feint again, but in vapor of ether a succession of feints can be induced, but not so many as in normal air.

Mr. DuPorte is inclined to the view that the death-feint reactions are largely *thigmotactic*, or responses due to the stimulus of touch. It is probable, he says, that the reaction is often complex, and involves the action of another stimulus besides touch.

It may be noted that the death-feigning instinct is not always advantageous to the insect, and can scarcely be considered as one evolved by natural selection for the benefit of the species.

Bohn is of the opinion that this instinct in insects is an exaggeration of the "differential sensitiveness" of simpler animals when a reaction is shown to sudden and marked changes in the strength of the stimulus. A shadow passing across a worm will cause it to contract for example.

Intelligence.

It is, however, among the higher and more specialised insects that intelligent actions can be observed superadded, as it were, to instinctive actions. Bees, wasps and ants have been carefully studied and observed for a long time.

Are these intelligent actions modifications of instincts due to their flexibility or variability, or have they originated apart from instinct? Does experience influence instinctive actions?

Professor Jenning's experiments with unicellular animals—the Infusorians—show that their behaviour cannot be explained as entirely due

to tropisms. Tropic reactions are obligatory and predictable, but Infusorians not only respond to stimuli but they put into practice the method of trial and error, which to a large extent dominates their behaviour.

Is this behaviour the emergence of intelligent behaviour among animals? If so, then among multicellular animals lower than vertebrates account must be taken of intelligence which has a modifying influence on instinctive actions. Instances of this interaction are numerous among insects. Bees sometimes cut a hole through the base of long-tubed flowers as an easy way of securing the nectar. Many of the actions of ants and wasps can be explained on the theory that they show some degree of intelligence. They profit by experience and are able to choose between alternatives.

The late J. H. Fabre, the great French student of insect life, who gave a long life to the close observation of the ways of insects, looks upon the instinct as different from reflex action and intelligence, and as something implanted in insects at the outset, and not derived from anything else. In his "Souvenirs Entomologiques" he gives numerous examples of the actions of insects. The action of the Sphex wasp in provisioning her home with paralysed crickets, if instinctive, shows considerable intelligence. That the intelligence is limited is shown by Fabre's experiment in removing the cricket a short distance from the entrance while the wasp was inspecting the burrow as was its custom. The wasp on its return found the cricket, brought it again to the entrance, but went again on an inspection of the burrow. Fabre removed the cricket forty times and the wasp went through the same routine.

The Digger Wasp, *Ammophila*, provides its young with live caterpillars which she first paralyses. This action, like that of the Sphex wasp, is not automatic but one of routine, and if this routine be disturbed everything goes wrong.

Fabre cites other cases of disturbed routine. He covered a wasp's nest with a bell-jar. The inmates were unable to get out because it was not part of their routine to dig under the jar. He joined the front and hind ends of a file of procession caterpillars, and "they went circling round and round the stone curb of a big vase in the garden day after day for a week."

Fabre also placed a slight paper cap over the lid of a mason bee's cell. So long as the cap was in contact with the lid the maggot had no difficulty in making its way out, but if a small space is left between the cap and the lid the maggot failed to escape.

Homing Instinct.

The so-called *Homing Instinct* is well developed in many insects, especially ants, bees and wasps. Experiments have been carried out by Fabre, Turner, Yung, Bonvier, the Peckhams, Bonnier and others, but the general opinion is that the ability of many insects to find their way home from a distance is not a special instinct but is due to many factors. "Associative memory," the "retention of effects produced by previous responses to visual stimuli" is an important factor according to Turner who believes that "ants learn to find their way. They make many mistakes at first, but gradually improve. They associate different impressions—smell, touch, sight, and remember certain finger-posts."

Fabre believed that bees and wasps had "une sorte d'intuition des lieux," and Bonnier takes the same view, for when bees were liberated from a box carried 2 kilometres distant from the hive they made a "bee-line" for the hive, although the box was separated by an intervening wood from the hive. "When their eyes were obscured by blackened collodion they still found their way. The removal of the antennae did not prevent their return."

Theory of Tropisms.

The tendency of recent research on instinctive behaviour is to refer it to tropism reaction, which is the result of the irritability of protoplasm. This, again, is based on changes in metabolic processes. This physico-chemical theory furnishes a plausible explanation why the response to a stimulus is not always the same, since the response depends largely on the physiological conditions of the organism at the time of stimulation.

According to the tropism theory instincts are *hereditary* in the sense that they reappear in succeeding generations, or whenever the conditions and factors are present which bring about metabolic changes corresponding to certain tropisms or groups of tropisms. The theory of tropisms explains the behaviour of most insects—their movements in search of food, their sexual actions, their actions in connection with the deposition of eggs on appropriate food-plants, their gathering together in certain places, etc. While tropisms may be linked together and specialized by natural selection into complex instincts, "they are not primarily dependent on specialized sense organs and nervous systems, but are fundamental properties of protoplasm common to all plants and animals." (*Goodrich*).

"Instincts are formed of a series of responses which must succeed each other when a particular stimulus is applied and reach a pre-determined

end, as surely as a piece of chocolate is yielded up by the "penny-in-the-slot" machine when the right coin is dropped in." (*Goodrich*).

Dr. Hans Driesch has said: "Instinctive behaviour is a complicated reaction that is perfect the very first time. This is illustrated by the action of the work bee that leaves the hive for the first time to collect nectar and pollen from flowers, and by the action of the larvae of the Sphex in devouring the paralysed crickets in the cells one after another."

Other Theories of Instinct.

It is evident that there are many grades of nstinct in the insect world, some simple or *primary*, others complex or *secondary*. Primary instincts may be, and probably are, largely tropic in their nature, that is they are reactions or responses to stimuli of various kinds. Secondary instincts, however, are more difficult to unravel, being combinations of tropisms. They occur in most insects, and are specialized in the higher Hymenoptera.

According to the Neo-Lamarckians, instincts represent inherited results of experience which have become automatic, but the objection to this view is that there is no proof that acquired characters are heritable.

According to the Neo-Darwinists, instincts are not the results of experience "either at the intelligent or the reflex level," but germinal variations which have been preserved by natural selection.

Bergson's view is that "instinct expresses a particular mode of knowledge, differing from intelligence rather in kind than in degree," and evolving along divergent lines from the beginning.

The *vitalistic* view of instinct championed by Bergson and Driesch stands opposed to the mechanical theory of Loeb and others. It assumes that there is something in the behaviour of organisms which the mechanical theory cannot explain. This something, called Entelechy by Driesch, is of a regulatory nature, directing the potentialities of the organism in such a way that its activities transcend those of pure machines. Vitalists see in living organisms a *unified behaviour* in which all changes are correlated to an extent not observed in machines. The living organism is "a self-stoking, self-repairing, self-preservative, self-adjusting, self-increasing, self-producing machine, and cannot be described completely in physico-chemical terms," (*Thomson.*)

Bergson thinks that at an early period of the world a "broad current of consciousness penetrated matter" and carried matter along to organisation. This consciousness launched into matter is *life*, and split up into

intuition or instinct and *intelligence*, seen in their highest in insects and man respectively.

"It lies dormant when life is condemned to automatism; it wakes as soon as the possibility of choice is restored." Instinct being so different in its origin from intelligence cannot be fairly described in terms of intelligence, but "it is not situated beyond the limits of mind." Bergson says: "In the phenomena of feeling, in unreflecting sympathy and antipathy, we experience in ourselves—though under a much vaguer form and one too much penetrated with intelligence—something of what must happen in the consciousness of an insect acting by instinct."

While the vitalists and the mechano-physicists wrangle over problems of life and its origin, the ordinary worker may console himself with the thought that the two schools view organisms from different angles and with different instruments, and hence their interpretations are different. There is much truth in both views, but on account of the limitations of the observer neither view probably expresses the whole truth. The vitalists see *consciousness* in an organism which responds to a *stimulus*, the mechanists find that *tropic* reactions are results of the *irritability* of protoplasm, which again depends upon *metabolic* changes. Is not the real trouble the fact that the vitalist's view is expressed in psychological terms, while that of the mechanists is expressed in terms of physics and chemistry?

Regarding the economic aspect of a study of tropisms, reference should be made here to a remark made by Prof. Herrick of Cornell University in his address as President of the American Association of Economic Entomologists. He says:—

> "Not long ago I had the opportunity of visiting certain intensely busy fields of economic entomological work in the southern part of the United States. During this trip, I saw two phases of work that greatly interested me and that left an impression on my mind that grows with the lapse of time. The two series of experiments dealt with the tropisms of two notorious insect pests—in one case with the chemotropism of a small beetle, in the other case with the phototropism of a small moth. I do not know that any satisfactory results in either case have yet been obtained. I do know, however, that these experiments are being made in a fundamental way and I feel that they are fraught with undreamed of possibilities in the way of insect control."

II.—INSECTS IN RELATION TO TEMPERATURE

It is a matter of considerable interest to know how the natural activities of insects are related to the temperature of the surrounding medium. Recently Bachmetjew, by employing delicate thermo-electric apparatus registering changes of temperature as small as .001°, has obtained results of considerable value.

His conclusions based on a long series of observations on insects are as follows:—

(a) The body temperature of insects at rest is practically the same as that of the surrounding air.

(b) Humidity is an important factor in modifying the effects of temperature. In air of normal humidity the temperature of Deilephila is lower than that of air when the temperature is raised. When paralysis of the wing muscles begins the temperature approximates and at death is the same as the air. If the air has a high humidity the moth has a higher temperature than that of the air and with a rise in temperature this difference increases. On the other hand, when the humidity is lower than normal the temperature of the moth is lower than that of the air.

(c) With the muscular activity due to body movements the temperature rises and when movement ceases the temperature falls. The body temperature of Sphinx pinastri rose 10°C. when it beat its wings rapidly, but no rise was observed when its wings simply fluttered.

(d) When an air temperature of 36°C. was reached the rapid wing strokes ceased—the stage of "partial muscular paralysis."

(e) With the gradual rise of the air temperature occurred a corresponding rise of body temperature by rapid wing motion. For example, Deilephila raised its temperature from 19.2° to 34.8°, from 28.5° to 37°, and from 29°-34° to 42.1°.

(f) Humidity has an influence on partial muscular paralysis—the drier the air the earlier does paralysis set in.

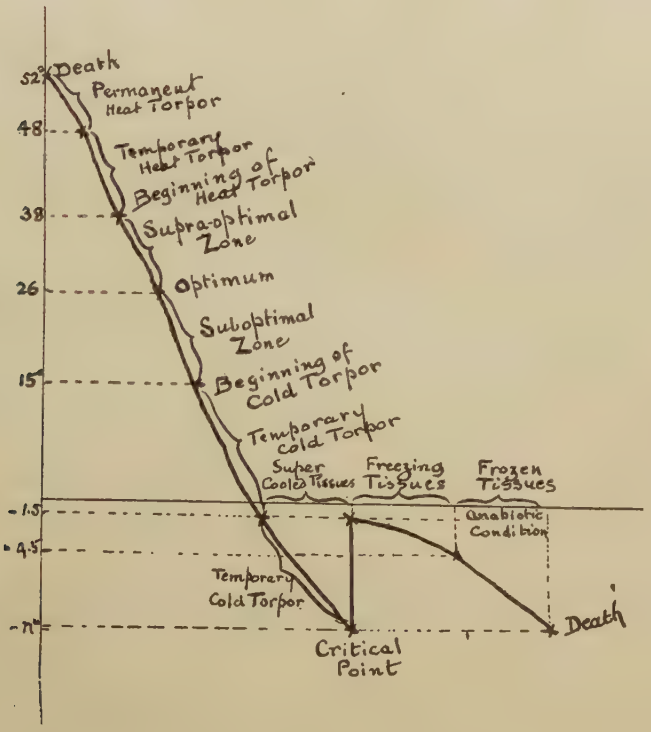
(g) The optimum air temperature is about 26°C.

Above the optimum temperature are the regions of *supra-optimum*, heat torpidity, transitory heat torpidity, *permanent* heat torpidity and death. Permanent heat torpidity appears as a rule at 46°C., although there are cases where it occurs several degrees lower, and also much higher, as in ants and scale insects. Higher temperatures cause more rapid meta-

bolism and it is probable that the insect dies of exhaustion. The rate of metabolism, humidity, and the thickness of the cuticle, the size, and the amount of water in the tissues of the insect have an influence on the vital maximum temperature.

At low temperatures some interesting differences appear before torpidity ensues. First an infra-optimum zone is reached, leading to cold torpidity at 15°C. This zone is quite variable in different species. *Aphis brassicae* has been observed in copulation at -7°C. and active Pemphigus plant lice -3°C. It appears, therefore, that insect tissues can be cooled below zero without freezing. The degree of sub-cooling depends to a large extent on the speed of cooling.

The lowest point of cooling is called the *critical point.* Then the temperature suddenly rises to 1.5°C. when the tissues begin to freeze. On further cooling the freezing advances until all the tissues are frozen, and the insect enters the *lifeless condition.* If a hard frozen insect in this condition is warmed it will come to life again. An insect in the *lifeless condition* is



Relation of insects to high and low temperatures. (After Bachmetjew)

not dead, but no metabolic changes occur. Moreover, it is not in a lethargic condition, for in a state of lethargy metabolic changes occur. Lower, it enters the stage of permanent cold *torpidity*, which ends in death. The temperature of permanent cold torpidity varies considerably. With larvae it lies between -4° and-42°C., with pupae between -4° and -25°C., and with adults between -1.5° and -35°C.

III.—HOW INSECTICIDES KILL

Contact Insecticides.

Until recently our information regarding the action of insecticides was vague and often incorrect. It was commonly stated that contact substances kill insects by stopping the breathing pores or plugging the tracheae, producing death by suffocation. The investigations of G. D. Shafer of the Michigan Agricultural College (Technical Bulletins 11 and 21), however, have shown that the old idea is mainly wrong inasmuch as insects are not readily suffocated. The death-producing action is mainly due to the absorption of the chemicals into the tissues. It was shown, for example, that the volatile portions of kerosene, carbon bi-sulphide, gasoline, creolin, pyrethrum, etc., were effective long before the liquids had time to penetrate the chitin or the spiracles into the tissues.

With the penetration of the volatile substances the nervous system is seriously affected, and results resembling narcosis produced, with a disturbance of the respiration activity. Insect tissues soon become saturated when exposed to the vapors of the substances mentioned, and death ensues through the inability of the tissues to absorb oxygen in the presence of these vapors.

In the case of lime-sulphur its effectiveness is due to its reducing power, and with scale insects to its softening action on the wax about the margin of the scales.

Alkaline washes, corrosive sublimate solution and other liquids which are able to dissolve or precipitate certain constituents of the tissues, pass through the chitin slowly.

Moreover, it was shown by Mr. Shafer that gasoline, carbon bisulphide, hydrocyanic acid gas, sodium fluoride, etc., when applied to insects, acted

strongly on the oxidases and other enzymes in the tissues, causing serious disturbances.

It was shown also that fat or fat-like membranes absorbed the vapor of gasoline and chloroform, but in doing so became less permeable to oxygen; that waxen membranes when wet with lime-sulphur also became less permeable to oxygen.

Non-volatile finely powdered solids, such as borax, hellebore, sodium fluoride etc., in addition to being stomach poisons, are effective also as contact insecticides because they adhere to exudations on the body wall, and later become dissolved and absorbed through the integument into the tissues.

APPLE PLANT LICE AND THEIR CONTROL

Dr. Robert Matheson, Cornell University.

There are three species of plant lice, the green apple aphis (*Aphis pomi*, DeG.), the rosy apple aphis (*Aphis sorbi*, Kalt.), and the grain aphis (*Aphis avenae*, Fabr.), which attack and injure the foliage and fruit of apple. Of the three species the grain aphis rarely does any particularly serious injury, whereas the other two species frequently become enemies of the first magnitude. These plant lice have come to us from Europe and they have been present and reported as injurious ever since the latter part of the first half of the nineteenth century. At the present time, they are widely distributed throughout North America and occur wherever the apple is grown. In order to present the subject matter as logically as possible I shall treat each of the species separately.

The Grain Aphis

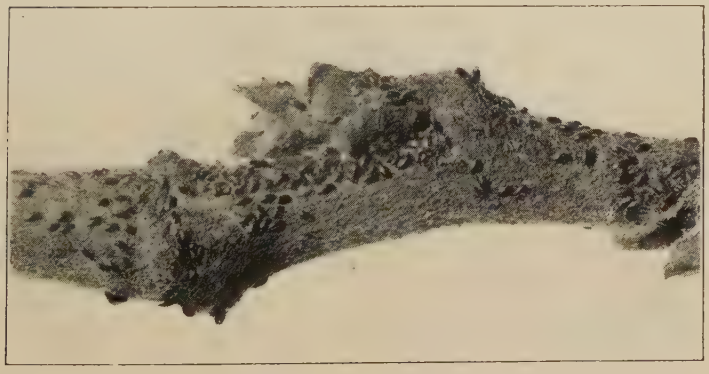
(*Aphis avenae* Fabr.)

This aphis uses the apple only as one of its host plants, chiefly for the deposition of its eggs and the developing of a few generations in the early spring. The overwintering eggs are found mingled with those of the other two species, though more generally distributed on the larger branches and even the trunks of the smaller trees. The eggs appear as small, oval-shaped, black objects.

The eggs of this species hatch earlier than those of the other two, at Ithaca at least eight or ten days earlier (Apr. 13, 1915). At this time the buds do not show green and the lice wander about a few days endeavouring to penetrate into the tips of the swelling buds. The length of time during which the eggs hatch was not determined. The stem mothers mature during the last days of April and the first week of May, at the time the blossom buds show pink. They are easily distinguished from the other two species. The grain aphis is bright green with three narrow longitudinal bands of darker green on the abdomen. This character will readily separate this species from the other two most liable to be confused with it.

Plant lice on opening apple buds; just right to spray. (Original).

Plant lice on opening apple buds; almost too late to spray. (Original).



Eggs of plant lice (Original)

Apple leaves curled by *Aphis sorbi* (Original)

Unfortunately no very extensive rearing experiments were carried on with this species. The stem mothers continued to produce young till the first of June, the maximum number produced by a single individual being 75. Many of the second generation acquire wings and have been frequently seen flying, apparently to their summer food plants. The first of this generation reached maturity on May 11. The second generation continued to produce young on apple till the middle of June and so far as I could determine all of them became winged and departed to their summer food plants. In my work many of the second generation and all of the third generation left the apple. Few are rarely seen after the first or second week in June.

The summer life-history of this species is fairly well known. Generation after generation of winged and wingless females is produced on the various grains and grasses throughout the summer and winged females return in the fall, in September and October, to the apple. Here true oviparous females are produced and winged males arrive to mate with them. The eggs are then deposited for the next year's generations.

The injury produced by this species to the apple appears to have been particularly negligible during the past two years. Whether it ever has done any considerable damage seems to me very doubtful, the injury undoubtedly being due to the other two species. When abundant it may almost completely cover every bud, as many as 70 to 80 being present on each bud. However the leaves open rapidly and they do not seem to cause any curling or distortion. In general it may be said that this species may be considered as not a serious pest.

The Rosy Apple Aphis

(*Aphis sorbi* Kalt.)

The rosy apple aphis has been a serious pest in American orchards for many years but it has been so confused with the other two species that even yet it is difficult to be certain as to which species a writer is referring. Furthermore it passes under several common names as rosy aphis, purple aphis, brown aphis, and others. Although described by Fitch in 1854 no definite account of its life-history appeared in American literature till that of Sanderson in 1901 and 1902. At the present time we know that this plant louse is widely distributed in the United States and Canada and probably occurs wherever the apple is grown commercially.

Like its related species, the grain aphis, this plant louse uses the apple only as one of its host plants. During the winter its eggs may be found, particularly on the fruit spurs and small twigs where they are tucked away in every crack and crevice or under overlapping bud scales. The eggs of the species cannot be separated from those of either the grain or green aphis. They hatch, however, about ten days later than those of the grain aphis and at the same time as those of the green aphis—at Ithaca about April 22 to May 3rd., that is over a period of 10 to 12 days.

The young of the rosy aphis usually are found hatching as the buds are distinctly showing green. They seem to prefer the opening flower buds and especially congregate on these. The stem mothers grow very rapidly and mature as the apple blossoms are opening. They are then usually congregated, when abundant, on the flower stalks, the leaves surrounding the flowers and even on the flowers themselves. The stem mothers as well as all the succeeding generations of this species are easily recognized. They are larger, almost globular in shape, of a somewhat reddish to purplish color and always covered by a whitish pulverulence. They begin producing young in great numbers and continue producing till the latter part of June. Their reproductive capacity is enormous, varying from 130 to 244 for a single individual over a period of about 33 days.

Many of the young from the stem mothers acquire wings and this serves to spread the second generation quite widely. They usually, however, remain on the lower parts of the trees, though when abundant they may be found on the highest branches.

The second generation becomes mature and begins producing young the last few days of May and early June. They continue producing young throughout June but their reproductive capacity is not so great as that of the stem mothers, varying from 70 to 162 per individual. A large number of this generation acquire wings and many, no doubt, migrate to their summer food plant though I have not been able to definitely determine this point except under cage conditions.

The young of the second generation, that is the third generation, reach maturity about the 10th to 15th of June and produce young till nearly the middle of July or in some cases even later. The reproductive capacity of this generation exceeds that of the second, averaging nearly 130 per individual. All of the descendants of the third generation, that is the fourth, acquire wings and migrate to the summer food plant, the narrow-leaved plantain (*Plantago lanceolata*). In our work this past season we thus

found four full generations to develop on the apple. In the fall return migrants appear and deposit egg-laying females on the apple and so the annual cycle is completed.

The work of this species on the apple is very characteristic and should easily be distinguished from that of Aphis pomi. As previously pointed out they congregate around the flower buds, around the developing fruits and on the under side of the foliage. Rarely are they found present on the succulent shoots, and when they are present are found on the under side of the leaves, curling them. This species causes practically all the severe curling of the foliage. A single rosy aphis on the under side of a leaf will frequently cause the leaf to become tightly curled and only a few are required to cause all the leaves on a fruit spur to become severely curled and distorted. Later they congregate in immense numbers on the developing fruits, particularly about the calyx and stem ends, causing them to become elongate, gnarled, and distorted. Frequently such work results in all the apples of a single cluster remaining on the tree, never fully developing and giving us what the fruit growers designate as "cluster apples." Sometimes these "cluster apples" may drop off in June, but many remain till picking time. When this louse becomes abundant, as it frequently does in June, owing to its enormous reproductive capacity, every leaf and fruit cluster on the trees may be infested and the result is the entire loss of the crop and the weakening of the trees. This is especially true if the ordinary natural enemies of plant lice fail to appear at the proper time, due as it seems to me, to cold or inclement weather conditions which do not seem to affect the rosy aphis.

The Green Apple Aphis

(*Aphis pomi* De G.)

The green apple aphis or apple leaf aphis is generally considered a recent introduction from Europe (1897). In my work I have shown that this species has been present in American orchards ever since the middle of the nineteenth century. This species remains on the apple throughout the season and has no alternate food plant. It is quite restricted in its tastes, being found on apple, pear, mountain ash, and quince. It is only on apple, however, that it does serious injury. Like the two species already discussed, it has been sadly confused in all our entomological literature. Not until 1897 was it definitely identified and Smith (1900) published

the first American account of its life economy. Since then several shorter articles have appeared from time to time but generally these have been only re-statements of the work of others.

This species always passes the winter as tiny, black, oval eggs scattered indiscriminately over the tender succulent twigs and branches, around fruit spurs and leaf buds, rarely on the larger branches. The eggs hatch in early spring just as the flower buds are showing green (that is about April 21 at Ithaca, N.Y. in 1915). The eggs continued to hatch till May 2nd though the greater majority hatched during the first four or five days. Of course, hundreds and thousands of the eggs fail to hatch owing to various not well known causes. This is fortunate for should all the eggs laid in any one fall hatch the following spring the infestation would be almost beyond our conceiving.

The stem mothers, as the young hatched from the eggs are called, attack the opening leaves and soon conceal themselves in the hairs deep down in the unfolding bud. They reach maturity in about fourteen to twenty days, that is between May 11 and 14th (at Ithaca, N.Y.). At this time the apple trees are just beginning to come into full bloom and give ideal conditions for the young from the stem mothers to cluster on the opening flowers. The stem mothers reproduce very actively, commencing within twenty-four hours of their last molt, and continue to produce over a period of 30 days or more, that is till about the middle of June. Each stem mother gives birth on an average to about 59 young. Many, however, produce more, but in my experiments this was the average for five individuals under fairly normal conditions.

The second generation reaches maturity in 12 to 14 days, and the greater majority are winged viviparous females. These fly readily from tree to tree and orchard to orchard and soon spread the species very rapidly. The reproductive capacity of winged females is much lower than that of the stem mothers and the period of reproduction is shorter. From now on throughout the summer generation succeeds generation of winged or wingless females with great rapidity and if natural enemies are not abundant and no artificial control measures have been used by the fruit growers severe injury and loss of the crop is bound to follow.

The habits of the species are in rather marked contrast to those of the rosy aphis. They congregate most commonly on the tips of the tender shoots, on the under surface of the leaves, and when abundant, like the rosy aphis, they attack the developing fruit. Crowding on the rapidly growing shoots

Aphis pomi—Injuring King apples (Original)

Aphis pomi congregated on young succulent twig (Original)

they soon kill them or prevent further growth. They do not produce any serious curling of the leaves, and when serious curling is seen it is pretty certain to be caused by the rosy aphis. Neither do they do so much damage to the setting fruit though here the amount of injury depends altogether on the extent of infestation. Their work on the fruit is identical to that produced by the rosy aphis. However, as this species remains on the apple throughout the season its injurious effects are not confined to the early summer months but it may by its continued work retard growth, prevent the full development of the fruit, and injuriously affect the setting of fruit-buds for the next year's crop.

In the fall, early in October or late in September, appear small wingless females and true wingless males. This is the egg-producing generation. All summer long generation followed generation without the intervention of males, but now in order to tide the species over the winter eggs must be developed. Each female, if it succeeds in mating with a male, lays from two to six fertile eggs. As the males are generally very few in number thousands of infertile eggs are laid and these shrivel up without ever hatching.

Before proceeding to a discussion of control measures, I wish to point out the conditions which give us such severe aphis infestations in June, just at the time when the apple is setting its fruit and requires all the nourishment it can secure.

Towards the end of June, at Ithaca, N.Y., the stem mothers both of the rosy and green aphis have ceased reproducing. The second generations of both species have probably just reached their maximum productive capacity about the middle of the month, while the third generations have well begun and will reach their maximum during the last week of June, and the fourth generation of the green aphis (*Aphis pomi*) has also begun reproducing. Such rapid reproduction by these two species during June soon produces the severe infestations which are so common during the latter part of June and early July. When these species are abundant I have seen trees so heavily infested in the early days of July that not a pin could be stuck into the tree anywhere without piercing several plant lice. In such infestation the loss amounted to several thousand dollars worth of fruit in a comparatively small orchard.

Control Measures.

Plant lice are capable of doing very serious damage because of their great numbers and their remarkable ability of very rapid reproduction. Although comparatively few stem mothers may hatch in the spring, yet, if conditions are favourable, the increase may be so rapid that severe injury may be done before it is observed. Then the lice may be so protected by the curled leaves that it is difficult to reach them by any spray, even though applied with great care and under very high pressure. From a close examination of the life cycle of these plant lice several vulnerable points of attack may be noted. These are:—(1) the destruction of the over-wintering eggs; (2) the destruction of the stem mothers when they are clustered on the opening buds; (3) the destruction of the lice before the leaves are badly curled, (in late May and early June); (4) the killing of the last generations in September to prevent the deposition of eggs.

Although many attempts have been made to reduce aphis infestations by the destruction of the over-wintering eggs practically all have ended in complete failure. Under normal conditions scarcely more than a small per cent of the eggs ever hatch, yet these, in a few generations, leave such hordes of offspring that in some years very serious damage is done. It seems useless to enter into a critical examination of the experiments so far undertaken, suffice it to say that no satisfactory spray mixture has been devised which will destroy the eggs though applied with extreme care. Another factor seriously limiting the usefulness of such a spray, even though capable of destroying the eggs without injuring dormant trees, is the difficulty of completely covering all the twigs and branches bearing the eggs, especially as so many of the eggs lie hidden away in every conceivable crack or crevice in the bark. It would thus seem that so far as our present knowledge goes we may hope to secure better control by attempting to spray when the lice are more vulnerable.

The next point of attack would be when the young, tender lice are clustered on the opening buds. It is possible at that time to destroy all the stem mothers and thus prevent further danger. If we could apply a spray when we know all the eggs have hatched and at the same time none of the leaf or fruit buds are so far opened as to offer protection from the spray, we might hope for complete success. From our life-history studies it is well established that the hatching of the eggs extends over a considerable period of time, at least twelve or more days. As these eggs begin hatching just as the buds are showing green at the tips and continue till the blossom buds show pink it would seem to be impossible to do this by one spray.

For at the time the last eggs are hatching the lice which have emerged earlier are nearly full grown and well concealed among the protecting hairs within the opening leaf and flower buds. However, can a spray be so applied as to destroy 90% to 95% of the stem mothers and is this sufficient to effectually prevent any serious damage? To this question a positive answer cannot be given at present, but data can be presented showing that it may prove feasible.

From our studies we have shown that practically all the eggs hatch within the first four or five days after hatching begins. During this time the buds have not opened to any considerable extent, the first leaves to appear being about the size of a dime and offering no considerable place for the concealment and protection of the lice. Can, therefore, the dormant spray be delayed to this time with safety and at the same time a material be added which will destroy the lice? This I think can be done with safety and our data seem to show that the lice can be controlled by such a spray. However, if a dormant spray is not required the application of the contact insecticide can be delayed a day or two provided the work can be accomplished before the buds have opened too much.

Experiments.

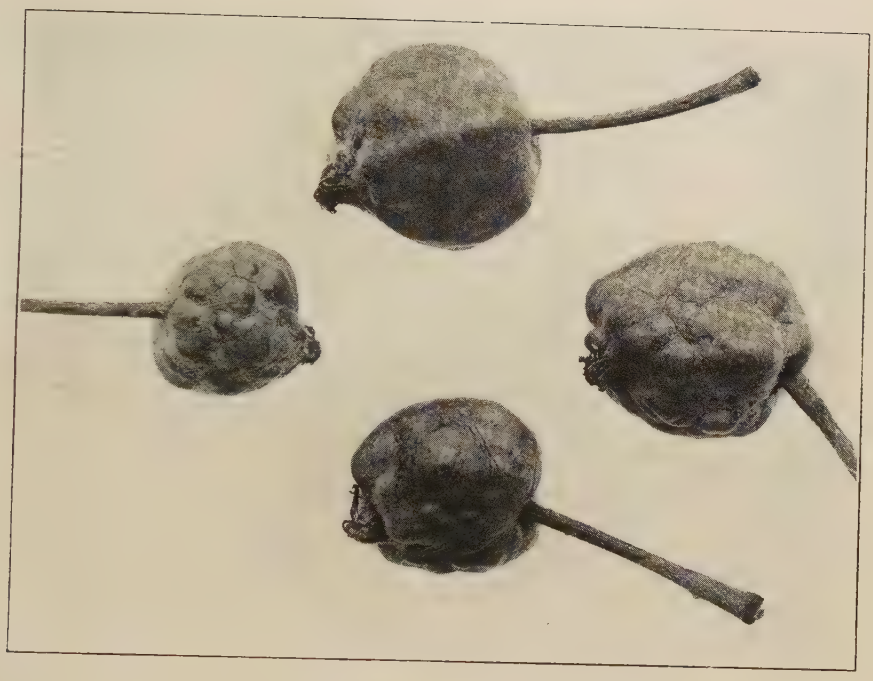
Through the kindness of the Department of Pomology permission was obtained to study the results of a dormant spray applied at the time the lice were congregated on the opening buds. The orchard is an old one consisting of tall, straggling trees of many varieties, some of which are very susceptible to aphis injury. The spray was applied by an old machine giving only about 100 pounds pressure. As a very high wind was blowing all the trees were sprayed on one side only, so I had an excellent opportunity to determine the exact effect of the spray. The trees were all badly infested, the grain aphis (*Aphis avenae*, Fabr.) being especially abundant. From a count of forty buds taken at random the number of lice per bud varied from 5 to 65 with an average of over 13. This was on April 22, 1915, the day on which the spray was applied. The sprays applied consisted of lime-sulphur (1 to 8) and "Black Leaf 40" tobacco extract ¾ pt., 1 pt. and 1¼ pts. to 100 gallons of the spray mixture.

On April 30 a close examination was made of the sprayed trees. The side of the trees which had been sprayed showed rather effective control though all the lice were not killed. The following counts of lice on buds

from sprayed and unsprayed sides of the trees will give some idea of the control secured:

Buds	Fall Pippin		Maiden Blush	
	Sprayed	Unsprayed	Sprayed	Unsprayed
1	2	6	2	3
2	1	5	1	5
3	0	3	0	3
4	0	5	2	2
5	0	2	0	1
6	0	0	0	2
7	0	0	0	0
8	0	2	0	1
9	0	0	0	0
10	0	0	1	6
11	0	0	2	0
12	1	2	3	1
13	0	3	1	1
14	0	0	0	1
15	0	0	0	1
Average	0.26	1.86	0.8	2.46

Although the greater number of the lice were killed, particularly on the sprayed side of the trees, yet enough were left to severely infest the trees.



King apples injured by plant lice—(Original)

On June 1 these trees were examined again and counts were made of infested buds from large branches chosen from the sprayed and unsprayed sides of the trees. The following table shows the results:

Aphis pomi and Aphis sorbi.

Variety	Leeward Side		Windward Side		% Leeward Infested	% Windward Infested
	Buds Infested	Buds not Infested	Buds Infested	Buds not Infested		
Fall Pippin	102	255	30	467	28.5%	6.4%
Tompkins King	65	91	32	178	41.7%	15.2%
Fall Pippin	71	197	14	236	27.5%	5.6%

It will be seen from this table that a very marked difference in the amount of control is shown. The winged forms have not yet appeared in large numbers so that they have not spread widely. Later the lice became widespread and occurred in large numbers but were not so abundant as to do any very considerable damage.

On June 17 another examination was made but the plant lice were so widely scattered that it seemed useless to make counts. At this time the Maiden Blush, Fall Pippin and Tompkins King were rather severely infested, whereas Baldwins, Westfield and Rhode Island Greening had only a scattering infestation. Even at this time there was a marked difference between the windward and leeward sides of the trees, the windward side (sprayed) showing a much lighter infestation.

Further experiments in the control of the apple plant lice were undertaken with the co-operation of Mr. Crossman at Wolcott, N.Y. In these experiments no checks were left but a neighboring orchard a few rods distant was used. In this work the following sprays were applied just as the lice were clustering on the opening buds (Apl. 21, 1915):

(1) Lime sulphur (1-8, and 1½ pts. "Black Leaf 40" in 100 gallons of the spray mixture).

(2) Whale-oil soap 15 lbs., carbolic acid (commercial) 1 lb., and water 100 gals.

Only 100 gallons of the first spray mixture were used on 20 trees, of which 13 were thoroughly treated from both sides. An examination on May 19 showed practically complete control, only a few lice here and there being found. The lice were so few and widely scattered that it did not seem feasible to make counts.

The second spray was used throughout the rest of the orchard. It did not prove so effective though the number of lice were so few that no damage was done to the fruit or foliage to warrant a second spraying.

In order to determine whether a second spray applied at the time the blossoms showed pink would aid in aphis control, Mr. Crossman applied a spray of commercial lime-sulphur (1-40) and "Black Leaf 40," ¾ pt. in 100 gals. of the spray mixture. He used a single tank of 100 gallons on a comparatively few trees and made a very thorough application. Although a close examination was made on May 19, 1915, no better results were apparent from the two treatments than from the single one applied as the buds were showing green. Later examinations confirmed this conclusion.

From these sprayings made under commercial conditions, Mr. Crossman is of the opinion that the lime-sulphur (1-8) with the addition of "Black Leaf 40," 1 pint to 100 gallons of spray mixture, gave the best results when applied as the buds were showing green. The whale oil soap combined with the crude carbolic acid also gave excellent results but was not on the whole so efficient though slightly less expensive.

In order to determine whether the addition of carbolic acid is an active agent in the destruction of plant lice several experiments were performed. The following two experiments seem quite conclusive so far as I can determine:—

(1). Carbolic acid (c.p.) ..... ¼ oz.
Water ..... 1 gal.

This was applied carefully to two badly infested seedling trees on July 7, 1914. On the 8th no effect on the lice could be observed except that they were actively migrating. The tender terminal branch was prac-

tically dead. Later the branch died back nearly 18 inches though the lice remained uninjured.

(2). Carbolic acid (c.p.).....¼ oz.
Lime sulphur (1-40)..... 1 gal.

The addition of carbolic acid to the lime sulphur produced a fine yellowish precipitate but no other change was noted. This mixture was applied to several badly infested trees and the results obtained were exactly identical with those from pure water and carbolic acid.

Although C.P. carbolic acid was used it seems to me that its insecticidal value would be as high as the commercial product. From several experiments along this line I am led to conclude that the addition of carbolic acid to a soap solution does not seem to increase its insecticidal value.

FIRE BLIGHT

Prof. F. Létourneau, Oka Agricultural Institute

Fire blight is the worst disease attacking fruit trees in the Province of Ontario. In the Niagara district it causes an annual loss amounting to several thousand dollars. It exists also in the Province of Quebec. In our orchards at La Trappe it has killed some pear trees. It is on this account I have chosen Fire Blight as the subject of this paper.

What Fire Blight Is; Its Causes.

Fire Blight, also called Twig Blight, Pear Blight, and Blight Canker, is a bacterial disease, attacking and killing different kinds of fruit trees. It is caused by a micro-organism called *Bacillus amylovorus.* This micro-organism finds a ready nourishment in the plant tissue of our most common fruit trees. Plants or animals cannot always resist the attacks of parasites or outside organisms. They struggle for a while and sometimes recover, but, frequently, if man does not protect them, they soon die. In the case of Fire Blight, the leaves suddenly turn brown as if scorched by fire, thus explaining the name of the disease.

Origin and Distribution.

Fire Blight is peculiar to North America, where it has been known for a century. Today we find it not only all over the United States but also in Ontario, Quebec and British Columbia.

Fruit Trees Susceptible to Attack by Fire Blight.

The disease does more harm to pear trees than any other fruit trees. It is for this reason that most authors call it Pear Blight. It appears that certain varieties have more resistance than others. In particular, the Kieffer and Seckel seem to be more immune than Flemish-Beauty, Duchess, Bartlett and Clap's Favourite. However, Fire Blight attacks not only pear trees, but also apple trees, especially during the early stage of its existence. In British Columbia it is said that Spitzenberg is the apple tree that suffers the most. McIntosh Red, in the same province, seems to be very resistant.

Besides pear and apple trees, Fire Blight attacks quince and even plum trees, hawthorn, and mountain ash.

Conditions Favoring the Development of Fire Blight.

This disease develops specially under hot and moist conditions, and its development is more rapid in the tender parts of a tree, such as the blossoms, twigs, suckers, etc. For rapid multiplication this bacterial organismn needs a certain amount of humidity, and finds, therefore, a good medium for such rapid development in young shoots and twigs of a tree where sap is abundant. This is the cause of the noticeable spreading in these parts. The disease is also more plentiful in orchards where rich and well cultivated soil enables the trees to make a rapid and vigorous growth. On the contrary cold and dry conditions stop the spreading of Fire Blight, as does a lack of sufficient moisture in the soil.

General Appearance of Fire Blight.

The general appearance of Fire Blight may be discussed under four heads:

A—Body Blight, or the disease of the trunk and limbs.
B—Twig Blight.
C—Blossom Blight.
D—Fruit Blight.

Body Blight.

When a tree becomes diseased with Body Blight, the affected bark turns a dark blue color, starts to swell, and from these swellings there exude numerous drops of a brownish, sticky liquid which run down the side of the tree in small rusty streams. Often the bark becomes badly blistered. The epidermis dries up and falls off, due to the death of the tissues. If such a bark is pressed with the fingers it feels soft and spongy. When a diseased area is cut into, the first thing noticed is the abundance of moisture in the fleshy bark and cambium. A deeper cutting shows the diseased cambium to be streaked with red.

Twig Blight.

This form of the disease may occur in foliage twigs, blossom twigs and suckers. In the majority of cases it develops from the blighted blossoms, but after this it is directly due to inoculation by sucking insects, which have previously been feeding on diseased twigs or suckers and have carried some of the bacteria on their mouth parts and introduced them into the healthy shoots. The appearance of the foliage in this stage of the disease has given Pear Blight the common name of Fire Blight. When the germs are introduced into the tender tip of a twig, they at once become active, and

after a very short time the delicate shoot begins to have a water-soaked appearance and becomes filled with a thick whitish fluid. Gradually the twigs turn brown and small beads of exudate appear which are white at first, but soon turn to a dark amber. The disease then enters the leaves causing them to turn brown and dry. They do not fall to the ground, but remain on the tree long into the winter. When the disease spreads downward into the more matured wood below, the bark wrinkles, and turns brown and finally black. The cambium is saturated with moisture and streaked with red. When the weather is warm and the tree is growing fast the disease spreads very rapidly.

Blossom Blight.

The bacteria gain their easiest access to the plant through the blossoms. The first indication of blossom blight is detected about two weeks after the blossoming season. The flower clusters are seen to turn gradually brown and shrivel up. The small immature fruit begins to take on a water-soaked appearance and seems to be filled with whitish juice formed by the bacteria. Gradually it commences to blacken and the disease can be seen working its way down the slender peduncle from which numerous beads of exudate emerge. Sometimes, chiefly on apple trees, the disease only enters the fruit spur and then dies off. But if it is the right variety of pear tree, and growing conditions are good, it often enters the branches. Blossom Blight is probably the most dangerous form of the disease.

Fruit Blight.

This form is not so important. Immature fruits are more generally attacked than mature ones. The disease may either enter the fruit by the peduncle from a diseased twig or by way of punctures through the skin. The flesh becomes spongy and shows large amounts of brownish exudate. The skin becomes deeply wrinkled and the fruit does not fall off.

Life Cycle of Fire Blight.

The disease passes the winter in the form of bacteria which lie along the advancing margin of the diseased portions, in the fleshy bark and cambium. This is known as "Hold Over Blight." In the spring, with the rising of the sap, the organisms become active, and produce a large amount of sticky liquid, which exudes in drops through the bark. This exudate, white and thin at first, becomes, after having been exposed to the air, a light brown or amber color, quite rubbery and almost hard in texture. This exudate usually appears shortly before the blossoms open, and attracts

many insects, which, when feeding on it, become smeared on their legs and mouth parts. They then visit the opening blossoms and deposit bacteria which multiply in the nectaries and then pass down into the stalk of the flower, and thence into the twigs, and branches. The sucking insects may also introduce the bacteria into succulent parts, such as twigs and suckers. This process of re-inoculation goes on through the whole season, leaving, when the wood becomes dormant, many cases of "Hold Over Blight."

Means of Control.

The germs of the disease, as we have already said, hibernate along the outer margin of the diseased tissue, between the living and dead wood. They are massed at these points and await the rising of sap in the spring to continue their development. It is up to us to destroy these germs before the awakening of spring. Therefore, in winter, or early in spring, it is advisable to examine the trunk and larger limbs of fruit trees to see if there are any cankers which must be immediately cut out. In doing so, great care should be taken to cut out not only the affected area of each canker but also a portion of the surrounding healthy tissue of the bark so as to be certain of destroying all bacterial germs. Then one ought to apply to the wound some white lead paint, and burn all that has been cut off.

In the early part of summer when Pear Blight is more apparent in the orchard, being detected by the sticky liquid exuding from the bark, a new inspection is necessary in order to destroy any affected area that has been overlooked during the winter visit.

In summer, two weeks after the blooming time, a third inspection is necessary in order to cut out all flowers attacked and also to destroy any affected new shoots or suckers that may appear, taking special pains to always cut 12 inches below the apparently affected area.

Also, a good preventive is to take out all suckers before they have had any chance of being attacked. A good way to control the dissemination of the disease is to be merciless towards aphids. It is not desirable to do the regular pruning while cutting out blighted wood. Germs would most probably be carried to sound parts of the tree.

It is necessary that after each cutting of any diseased portions the tools used be disinfected by bichloride of mercury or corrosive sublimate, 1 part in 500 parts of water. The wounds must also be disinfected.

As pear trees are favorite hosts for Fire Blight, Quebec will not have to suffer so much from Pear Blight as Ontario, since we have comparatively few pear trees. The apple tree is more lightly attacked.

REPORT OF THE DELEGATE TO THE MEETING OF THE ONTARIO ENTOMOLOGICAL SOCIETY HELD AT OTTAWA

By Rev. Father Leopold, La Trappe, Que.

For the second time, in company with our friend Mr. J. C. Chapais, it was my pleasure and benefit to take part in the Annual Meeting of the Entomological Society of Ontario as your delegate.

The Society convened at Ottawa, on the 4th and 5th of November in the large laboratory of the Entomological Branch of the Department of Agriculture.

Dr. C. Gordon Hewitt, Dominion Entomologist, presided until one of the members of our Quebec Society, Mr. A. F. Winn, of Westmount, was appointed to take the presidential chair.

The papers presented at the meeting were of great interest, for they were in most cases followed by valuable discussions. The whole range of agriculture was brought before the meeting, general farming, horticulture and fruit-growing, as well as forestry, for insects, both beneficial and noxious, in all these different phases of agriculture, were mostly spoken of in some way or other during the two days of the convention.

I do not intend to report even hurriedly all of the valuable papers, as you will find them in the annual report of the Society, of which most of us are members. But I will dwell chiefly, in these short remarks, upon the work done by the Dominion Entomological Branch, and also upon a few insects that interest the fruit-growers especially.

We all know the important place the Brown Tail and Gypsy Moth have taken in the States and in Nova Scotia and New Brunswick. For some years parasites of both these insects were reared and disseminated over infested areas in the States, and now the Entomological Branch has undertaken valuable work along the same lines, with the co-operation of Dr. L. O. Howard, Chief of the United States Bureau of Entomology. Through his courtesy the rearing of parasites has been carried on for the past four seasons in the Brown Tail Moth Laboratory at Melrose Highlands, Massachusetts.

Mr. Leonard McLean, field officer in the Entomological Laboratory at Fredericton, N.B., in a paper he presented gave us an idea of the work accomplished at Melrose in raising the parasites. As the Brown Tail Moth in Canada is happily not yet widely spread it was necessary to choose

parasites which were parasitic not only on the Brown Tail Moth but on native insects as well, otherwise there would be little chance of the parasites becoming firmly established. So two species, *Apanteles lacteicolor Vier.*, and *Compsilura concinnata* Meig. and one predaceous beetle, *Colosoma sycophanta L.*, were chosen for the purpose.

Apanteles lacteicolor is a small hymenopterous parasite measuring only 2.5 mm. in length. This insect has two or three generations a year, for after emerging from the Brown Tail Caterpillars it may attack either the Gypsy Moth, *Datana*, or *Hyphantria* caterpillars, the second or third generation carrying them through until the Brown-tails have hatched in the fall. The parasites are in the cocoon stage when they are picked and forwarded to Canada for colonization.

Compsilura concinnata is a Tachinid Fly, resembling somewhat the common house-fly, though smaller and never found in the house. Like the preceding parasite, it has two or three generations a year, and has a record of some fifty different species of insects as hosts to feed upon.

Calosoma sycophanta is a brilliantly coloured, green beetle measuring a little over an inch in length. Predacaous in its habits, it feeds upon many species of caterpillars. Shipped in colonies of males and females, 100 to the colony, 3,400 adult beetles thus far have been forwarded to Canada.

In another address given by Mr. Tothill, field officer at the Dominion Entomological Branch, Fredericton, N.B. we learnt some of the important points relating to the spread of the insects for which the Government is importing these parasites.

Introduced near Boston, Mass., the Brown Tail Moth and the Gypsy Moth have spread in all directions but more rapidly in the direction of the prevailing winds, that is towards Canada. The Brown Tail has reached Canada already and is established in Nova Scotia and New Brunswick. Now we are assured that the Brown Tail will also reach the Province of Quebec with favorable winds at the time of the flight of the Moths. The Gypsy Moth has not yet reached Canada, but we may soon expect it across the international boundary. Therefore *Calosoma sycophanta* has been distributed in Quebec Province in the following places: Ste. Rose, Revoirs Corners, East Hereford, Sherbrooke, Dixville,Coaticook, Beaver Meadow, North Troy, Mansonville and Stanstead, while the *Apanteles lacteicolor* was released (2000 at each place) at Dixville, Coaticook, Beaver Meadow and Way's Mills.

Among the many interesting addresses and papers of special interest to the fruit-growers, I may mention those dealing with the Fruit Tree

Leaf Rollers and the Green Apple Bug on apples and pears, the first by Prof. Caesar of Guelph, and the other by Prof. Brittain of Nova Scotia.

There are two moderately common leaf rollers that attack fruit trees, especially apple and pear trees in Ontario. The first is known as the Oblique-banded Leaf Roller and the other the Fruit Tree Leaf Roller. These insects have not been very noxious as a general rule in the past decade, with the exception of the last three years. They seem to attack a single orchard in a place rather than the whole area devoted to fruit-growing; and at other times will attack only a certain portion of an orchard, leaving the rest in a healthy condition.

The adult of the Leaf Roller is a small moth, about half an inch long when the wings are closed, but with a wing expanse of nearly an inch. The upper wings are a rusty brown with several silvery-white markings; the hind wings are a light ashy brown without any markings. The larva when full grown is a slender caterpillar nearly an inch long, and of a pale, yellowish green color, with a black head. They are usually to be found in a rolled up leaf. When disturbed, they quickly wriggle out of the leaf, and drop down on a silken thread. When danger is past, they crawl up this thread to the tree again.

The larvae of the Fruit Tree Leaf Roller attack the leaves, the fruit buds or blossoms and also the fruit. The attack on the leaves begins about the time the buds begin to open. At this date the little larvae have just hatched out of the egg. They at once work their way in among unfolding leaflets, fasten them together with a few silken threads and feed upon the inner tissues in this sheltered position, where it is clear one cannot reach them with any contact poison. The fruit buds are often bored into and destroyed, but apparently the chief injury is done here to the fruit. Once fruit begins to form, the caterpillars prefer it to anything else and they eat holes in it. These holes frequently extend to the core but often do not go so deeply. The worst injured apples drop; the rest remain on the tree and are deformed and no better than culls.

Arsenates will not be sufficient to control this pest, as not more than 50% of the larvae are thus destroyed. This application is made with 4 lbs. in 40 gallons of water or Lime Sulphur Solution, applied just before the blossoms open and a second just after the petals fall. Be thorough and cover every leaf if possible.

But the best remedy is *scalecide*, which is a miscible oil spray made by the B. C. Pratt Co., 50 Church St., New York City. It costs about $30.00 a barrel, and should be diluted at the rate of about 1 gallon of scale-

cide to 15 gallons of water, thus making 16 barrels of spray mixture with one barrel. When diluted, the mixture looks like milk and is easy and pleasant to use.

Apply the liquid just before the leaf-buds burst, so that the egg-masses may be hit. Great care must be taken to see that every egg-mass is thoroughly wet. This will destroy the eggs or prevent the larvae from hatching. The eggs are laid on the twigs and on the branches; so keep this in mind when spraying.

The Green Apple Bug, *Lygus invitus*, also known under the name of the False Tarnished Plant Bug, is a pest of apples and pears, and was the subject of Prof. W. H. Brittain's paper. The excellent illustrations gave the members present a splendid opportunity of becoming familiar with the bug and its injuries to the apple and the pear.

The insects cause the injury in the wingless stage, when they resemble long legged aphids and are very active. From observations made, the insect comes out over a considerable period, but by the time the blossoms fall, the greater number of them will have emerged. Damage usually begins by the piercing of the young and tender leaves. An apple leaf severely attacked appears as if covered with tiny little pricks. The chief injury made by the bugs, however, results from their stinging the small fruits of the apple and the pear. On the apple these punctures become in time small warts or protuberances upon the surface of the fruit, which later turn brown at the heart and eventually drop off. Larger apples are malformed and frequently present a curiously scarred and twisted appearance.

Control:—From a study of the life history and habits of the insect, the following spray will be found of use: Black Leaf 40, ¾ of a pint to 100 gallons of water, applied at the period of maximum emergence, which will be about the time blossom petals fall. But it must be remembered that the bugs have a great ability to hide. Consequently great care must be exercised to cover each one with the spray. Prof. Brittain hopes to be able to give more complete information about this insect next year.

At the evening session Dr. H. T. Fernald gave a most interesting address in the assembly hall at the Normal School.

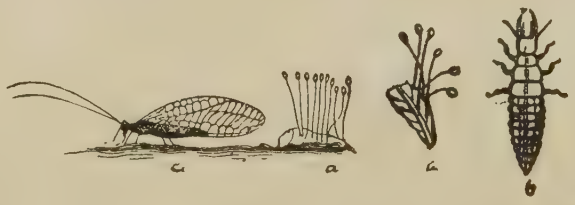
THE CHRYSOPA OR GOLDEN-EYED FLY

J. C. Chapais, St. Denis-en-bas, Que.

The Quebec Society for the Protection of Plants has within its sphere of action two missions to fulfil; first that of studying carefully the insects, fungi, weeds, and the diseases against which valuable plants need protection, and second, that of studying the insects and the remedies which are helpful to man in his work for the protection of plants.

Today, I wish to speak to the members of the Society about a useful insect which is the relentless enemy of a whole class of insects injurious to a multitude of useful plants. The insect belongs to the Order Neuroptera, the Family Hemerobiidae, and to the genus Chrysopa, of which a dozen species are known in the province of Quebec. Here is a very fine description of Chrysopa given in an issue of "La Nature," a Scientific French review, April 4th, 1914, by Mr. René Merle:

"The Golden-eyed Flies, what a pretty name for an insect, and how gracefully it is carried by the Chrysopae or Hemerobii, those small neuroptera with a pale emerald green body, pellucid iridescent wings ribbed with



Chrysopa, Golden-Eyes, or Lace-Wing—*a* eggs on end of stalks; *b* larva, called "aphis-lion"; *c* adult chrysopa or lace-wing.

green and, above all, eyes like living jewels, glowing with all the tints from burnished gold to emerald and from lapis to ruby. This living marvel is not only content with its beauty, but further is of service to mankind in giving us most efficacious aid."

According to Provancher (*Faune Canadienne*), the larvae of the Chrysopa live in the open air on plants, and feed on plant lice (Aphides) or Chermes larvae. The perfect insect lays its eggs on long slender pedicels which it attaches to the twigs and leaves of trees.

The body of the Chrysopae, which are also named "Laced-winged Flies," is soft and tender. All the species are green, of a more or less dark

hue. They often enter living rooms in the evening, and they have the faculty of emitting a very disagreeable smell which often is sufficient to betray their presence even before the eye has caught sight of them. The larvae, in undergoing their metamorphosis, spin a cocoon of closely woven silk hidden in the chinks of the bark.

These insects are commonly found some years, in June and July, in meadows. Their flight is slow and toilsome. The larvae, as mentioned above, are carnivorous and feed on plant lice, on larvae of Chermes and Curculios. The perfect insect lives on nothing else than the juice of flowers and does not injure them in any appreciable manner. The egg hatches seven days after being laid and the larvae keeps alive for twelve days. As soon as it has left the egg, it begins to prey on plant lice often twice as large as itself. It may eat up thirty or forty of them in an hour. The larvae have a flat wrinkled, hairy body and their head is provided with very powerful mandibles. At the end of about twelve days, they use their spinneret, (contrary to the caterpillars which have it at their anterior end they have it on the last segment,) to spin an almost spherical cocoon, so constructed that the perfect insect may enlarge from an aperture closed by a sort of cap. The larva is so voracious that, at the period of its change to a chrysalis, it eats sixty plant lice in sixty minutes. Hence, the common name of "Aphis-lion" given to it.

It remains enclosed in the cocoon for sixteen days, at the end of which time it comes out a perfect insect which almost instantaneously becomes twice as large as the cocoon in which it was enclosed. Its stretched wings take on all the hues of the rainbow, its body assumes its green hue, and its eyes their golden color as it takes its flight, leaving the cocoon empty but saturated with the nasty smell which exhales, as said above, from this beastie. Seven days in the egg, twelve days as larva, sixteen days spent in the cocoon—this gives a period of five weeks, constituting the cycle of the existence of this insect before it becomes perfect. When one knows that each female lays forty eggs per night, he has a good idea of the prolificacy of this family of insects and understands how much it deserves our consideration when we bear in mind the efficacious help it gives us in the destruction of Aphides, Chermes and curculios. Let us pay it as much respect as it deserves for its usefulness.

GRASSHOPPERS AND THEIR CONTROL

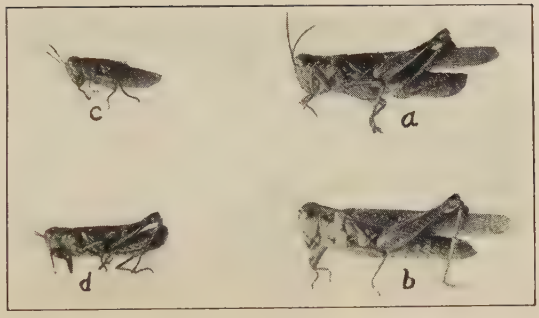
Arthur Gibson, Chief Assistant Entomologist, Department of Agriculture, Ottawa.

Locusts, or as they are more commonly called grasshoppers, have long been known to destroy crops of various kinds. Fortunately the notorious Rocky Mountian Locust which in years gone by destroyed many thousands of dollars worth of growing crops in western Canada, has not since 1904 caused any serious damage. A closely allied species, however, known as the Lesser Migratory Locust, which is a native kind, occurs all over Canada, and, during recent years, has in the eastern provinces caused much injury to growing crops. In certain districts of Quebec Province whole farms have been abandoned owing to the complete devastation caused by the locusts in previous seasons. Sandy areas that had been reclaimed had reverted to the original condition as the locusts had destroyed the grasses and vegetation binding the sand and preventing its drifting.

The locusts are true biting insects and feed actively throughout all their stages after hatching from the eggs. The latter are deposited freely in packets or pods, chiefly in old, neglected pasture lands, and along roadsides, etc., in spots where the soil is dry and largely free of vegetation. The number of eggs in each pod varies with the species. Some pods contain only 10 eggs while others contain as many as 70. They are deposited in late summer and in autumn, the young locusts not hatching until spring of the following year.

Towards the end of May, 1915, young locusts began to appear in noticeable numbers in the provinces of Ontario and Quebec, but owing to dull, cool weather conditions did not become active until the first and second weeks of June. From many townships and parishes in these two provinces reports of the presence of locusts in destructive numbers were received. The crops attacked were chiefly oats, barley, timothy, buckwheat, clover, tobacco, potatoes and corn. In one instance near Ottawa about 6,000 celery plants were destroyed.

The writer has seen several serious outbreaks of locusts in previous years but never until last June were the insects observed by him in such enormous numbers as at Bowesville, Ont., and Lanoraie, Que. In fields which were examined the locusts were present in countless thousands. The soil is similar in both localities, being of a light sandy character, and in



Lesser Migratory Locust—the chief destructive grasshopper in Eastern Canada. *a*, adult male; *b*, adult female; *c*, *d*, young hoppers. (Author's illustration).

Showing portion of farm abandoned owing to locust outbreaks. A typical breeding place for these insects.

both places are large, neglected areas which furnish ideal breeding grounds for the insects.

The Entomological Branch had, therefore, excellent opportunities of further demonstrating, in the provinces of Ontario and Quebec, the value of poisoned baits to control such insects. Not only has our demonstration work given every satisfaction to the farmers in the districts where it was conducted, but we have also been able to prove the value of certain entirely new poisoned mixtures, concerning which, however, more will be stated after another season's work.

In control measures against these insects it had been observed that the juice of such fruits as lemons and oranges was very attractive to the insects and this therefore suggested the idea of adding such fruit to a mixture of bran, molasses and water poisoned with Paris green. In 1914 the value of such a mixture was demonstrated and in one field we counted in one instance 414 dead locusts in one square yard. In an oat field the same mixture this year (at Bowesville) killed, on an average, 184 locusts to the square yard, the largest number of dead insects found within one square yard in this field being 736.

The following mixture was distributed over 5 acres of heavily infested oats on 26th June, on which date the plants were from 9 to 12 inches high: bran 20 lbs., molasses 4½ quarts, Paris green 1 1-6 lbs., water 2 gallons. The counts made four days later indicated a remarkable death rate. The ten counts made diagonally across the field gave 246, 840, 509, 473, 210, 368, 230, 1200, 616 and 450, an average of 514 dead locusts to the square yard.

During such times as the present when our farmers are striving to grow larger and better crops, it is very gratifying to us to have been able to render help in districts where the locusts were abundant. From information that we were able to give an important saving of crops has taken place in localities where the farmers organized to co-operate and treat large infested areas at the same time. The most remarkable illustration of the value of such co-operation was in St. Maurice County, Que., where following our directions, the farmers of the parish of St. Etienne organized under the immediate guidance of the Rev. J. I. Trudel. In this parish, practically all farm land—estimated at 20,000 acres—was treated with the poisoned bran mixture, in the week beginning June 4th, at which time the locusts were about one quarter to one-half an inch in length.

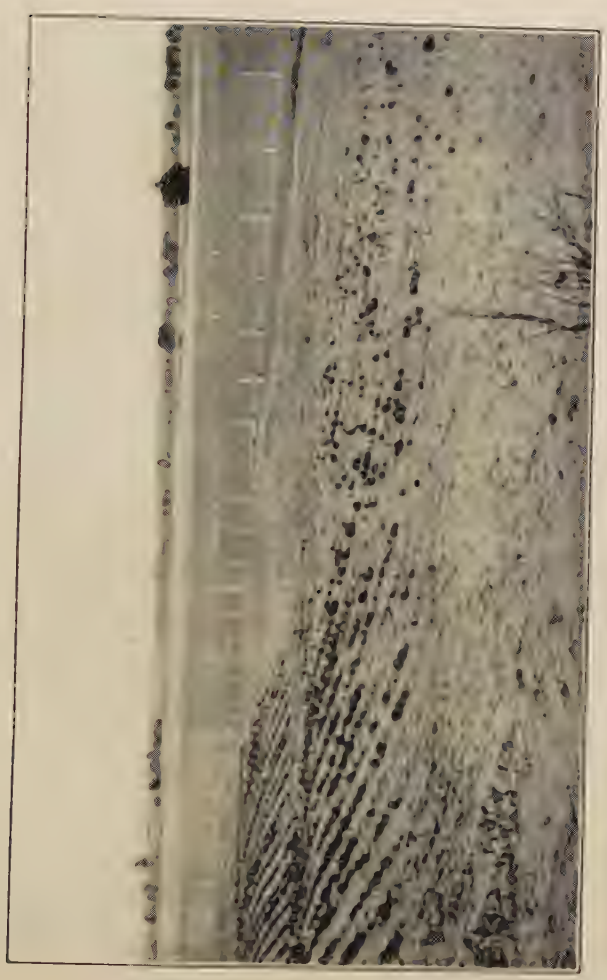
I visited St. Etienne de Gres on June 23rd and in only one or two small areas, which had not been treated, owing to the fact that they were owned by an outside corporation, could locusts in numbers be observed. In the

treated fields examined very few living locusts were present and the farmers were quite satisfied that the application of the poisoned bran had saved their crops from being destroyed. The farmers in other parishes in Quebec province also organized in a similar manner, with excellent results.

As the locusts do not feed at night, they are always hungry in the morning and for this reason the poisoned bran is spread in the fields as early in the day as possible. Since very little of the bran is eaten after it becomes dry, scattering it broadcast in the morning and very thinly, places it where the largest number of locusts will find it in the shortest time. Sowing it in this manner also makes it impossible for birds, barnyard fowls, or live stock to secure a sufficient amount of the poison to kill them. Inasmuch as the poisoned bait does not act quickly, it will be from two to four days before the insects are found dead, and these will be more numerous in the sheltered places. It does not require much of the poison to kill them. Even a small portion from one of the poisoned flakes will be sufficient to cause death.

In our experiments we found that 20 lbs. of bran, 1 lb. of Paris green, 2 quarts of molasses, the juice of three oranges or 3 lemons and about 2½ gallons of water made a mixture sufficient to treat 5 acres of growing crops. In preparing the bran mash, the bran and Paris green are mixed thoroughly while dry. The juice of the oranges or lemons is squeezed into the water, and to this is also added the pulp and peel after cutting into fine bits. The molasses should then be added, and when dissolved the mixture should be poured on to the dry bran and poison, stirring the whole constantly so as to dampen the bran thoroughly.

The mixture of course is not applied to all of the land, but scattered thinly here and there throughout the fields. In this way sufficient of the bait will be distributed to attract the locusts from considerable distances. The best results in destroying these insects will be obtained before they reach the winged state and are of about from one-quarter to one-half an inch in length.



Portion of farm devastated by locusts; corn field entirely destroyed in the foreground. (Author's illustration).

SOME POTATO PROBLEMS

P. R. Cowan, Division of Botany, C. E. F., Ottawa

Little does the average man realize the vastness of the potato industry in Canada, where potato culture is still in its infancy. From statistics for the years 1914-16 we find the value of the potato crops ranks high in the Dominion. In 1914 Canada produced some 85½ millions of bushels of potatoes which valued at 49 cents per bushel gave a return of $41,598,000; whereas in 1915 the estimated crop of Canada was only 62½ millions which valued at 57 cents per bushel gave a return of $35,964,000. Those amongst us who have had anything to do with the buying of potatoes this year know that the price is away above the average price, which for the last five years averages at 49 cents per bushel. So bearing this deficit in production in mind I intend to put before you some of the problems that have influenced this.

The chief cause of the deficit I think may be largely laid to the door of disease, so as time will not permit more I shall only deal with this cause this afternoon.

Susceptibility to Disease.

At the present time very little is known about resistance of varieties to disease. I think one of the greatest reasons for lack of knowledge is due to the over-whelming numbers of varieties we have grown in North America. As a rough estimate I would say that there are at least 2,000 varieties known in Canada and the States. We have at the present time one or two varieties that are resistant to one or two diseases but more or less susceptible to others. As a rule the earlier varieties are subject to Late Blight, and the later one more resistant to Late Blight. Resistance to disease is usually associated with stiff upright woody stems, small firm hairy leaves and dense foliage. Again, a potato that is resistant to disease in one locality may not be resistant in another locality. I cannot give you actual data for this statement, but in the course of discussion with Mr. Davis, Assistant Horticulturist at Ottawa, we came to the conclusion that notes taken on varieties in N. B., did not show the same results as at Ottawa, although the seed was originally from the same source. This is further borne out by experiments in England with Canker resistant varieties. Change of locality and climate seem to alter the resistant quality of varieties.

Storage Rots of Potatoes.

These rots may be caused by a variety of agents. A perfectly ripe potato, if free from disease, is more likely to be a better keeper than an unripe potato. What do we mean by a ripe potato? A ripe potato is one that is in the best condition for digging. The time to dig potatoes depends largely on individual conditions on the various farms. As a rule potatoes on wet soils should be dug early, and on dry soils later, they should also be dug later when the crop has been badly affected with disease, so as to show the diseased tubers, so that when they are picked up the diseased tubers may be removed and not put into storage to affect others. Where the crop is not affected with disease it should be harvested as soon as the tops die down naturally, or are killed by frost. Killing by frost leads to another cause of Storage Rots; often when the potatoes are not properly hilled, tubers near the surface will get touched with the frost and these tubers when placed in storage will rot and spoil the others with which they come in contact. Another cause of these storage rots is carelessness in handling the crop. Where a potato digger is used the potato is often badly cut by the digger. This is usually caused by not digging deep enough.

Conditions of storage are often such that the numerous fungi and bacteria are placed in the very best of condition to thrive and infect the potato. The starch of the potato is one of the very best of foods for these fungi and bacteria. The cellar should be kept at a low temperature and not too moist, if possible, a temperature not more than 40° F. is advisable; there should be no superfluous moisture that will cause a moisture to settle on the walls, and not too dry to cause evaporation from the potatoes.

A few suggestions to remedy these conditions mentioned above are:— Harvest when ripe, or if diseased just before frost, discard all diseased tubers in the field, spray regularly your growing crop; take care not to damage tubers when digging; keep the cellars cool, below 40° F., and look over the crop from time to time discarding all diseased tubers.

Symptoms of some of the Common Diseases.

The Late Blight is characterized by the spots on the leaf of a lighter colour usually surrounded by a darker ring or water soaked area; on the under side of the leaf there is a white powdery or downy appearance. This spot may dry up and not do further damage, but in a warm moist summer such as last, the spots will increase and in a very short time the whole foliage of a field will be killed right down. This disease may be controlled by spraying with Bordeaux. *Early Blight* which does not do a very great

deal of damage, although in some parts of the States does as much damage as Late Blight in Canada, is characterized by the target marked spots of the leaves. The spots are usually brown and have concentric rings or marks. This disease is also controlled by spraying with Bordeaux.

Rhizoctonia, according to reports from many sections of Canada did considerable damage. Rhizoctonia is known by many symptoms. The leaves usually have a slight yellowish tinge, form in cluster, hence the name of Rosette which it often goes under. There is also a curl of the leaves. In bad cases aerial tubers will form, and in all cases the tubers will form very close around the stem near the surface, and will be small. I have seen samples where there were hundreds of potatoes the size of tip of my little finger, hence another name that Rhizoctonia often goes under, "Little Potato Disease." These symptoms are similar to other stem diseases, but on pulling the stem lesion will be noted on the stem just below the ground These lesions are in the form of cracks covered with brown mycelium giving a brown appearance. This distinguishes Rhizoctonia from all other diseases. The disease winters over on the potato in black spots or scurf. It is controlled by selection and treatment of seed.

Blackleg is a bacterial disease causing a wilting and turning yellow of the leaves, and a blackening of the stem at and below the ground. The plant will fall completely over and die. The tubers of an infected plant will show a discolouration in the vascular ring in the early stage and later a complete blackening and softening of the inside of the potato. Controlled by the selection of good seed; all discoloured seed should be discarded when cutting and also throwing out discarded hills in the growing crop.

Fusarium Wilt also causes discolouration and wilting of the leaves, but characteristic of the disease is the discolouration of the vascular system of the stem just below the ground. The stem when cut shows a brownish ring or markings in the vascular bundles. It is controlled as for Blackleg.

There are also three diseases of unknown origin, that do not show in the seed tuber but do considerable damage to crops, namely, Mosaic disease, Curly Dwarf and Leaf Roll.

Mosaic is characterised by the mottled and puckered appearance of the leaf. The leaf is normal except for the lighter spots or blotches which are usually somewhat puckered.

Curly Dwarf usually shows a dwarfing and rolling of the leaves. The stems, petioles and veins all seem to be shortened, giving a puckered compactness to the leaf. There is a tendency for excessive branching causing a distinct clustering.

Leaf Roll. The leaflets and leaves usually roll upwards on their midribs, often forming a nearly tubular shape. The growth is lessened and the leaves are often discoloured, and it will be found when the plant is pulled up that the mother tuber is entirely intact and in a good state of preservation. The symptoms are similar to other diseases as Blackleg, Rhizoctonia etc., but the other diseases invariably show the characteristic symptoms of that disease, whereas the well preserved tuber seems to be characteristic of the Leaf Roll.

The last mentioned three diseases are only controllable by eradication or removing from the field of all diseased or discoloured plants. There are three important diseases of the tuber, namely, Common Scab, Powdery Scab, Canker or Black Wart. The first two to the uninitiated are somewhat similar, and to the expert hard to diagnose by the naked eye.

Common Scab. The scabs or lesions are usually shallow and composed of corky material. The scabs are usually large and irregular in shape, and in bad cases the scab becomes one mass and covers the area entirely, making separate scabs indistinguishable.

Powdery Scab. The scabs are usually small, roundish, the outline being bordered by the upraised outer epidermal layer of the tuber, so that small pits are formed, which at maturity are filled with a brownish, or olive green powder or dust. Each scab, even in a bad cluster, is almost distinct, that is, a point outline of each scab may be traced.

For the benefit of those who do not know Powdery Scab, a comparison of the two scabs may not be out of place.

The scabs of Powdery Scab are usually isolated, circular and smaller than Common Scab. The edge of the scab is usually surrounded by an upraised layer of the epidermis of the potato giving the appearance of a crater or cup. The pits are usually deeper and filled with brownish powder while the Common Scab is shallow and filled with corky material. In the early stage Powdery Scab somewhat resembles a half pea and can easily be rubbed away from the tuber.

Canker. At present not known in Canada or the States although present in Newfoundland. Canker deforms the potato into an irregular, warty, and at first greenish body. In the early stage the eyes first appear grayish, then turn brown and finally black.

The common scab may be controlled by the treatment of the seed. Powdery Scab and Canker when once introduced are not controllable, except by rotation and not planting on soil that has been infected for at least seven years.

Silver Scurf. It is confined to the skin of the potato tuber and makes its appearance as ashy-grey spots on the surface. These become larger as time goes on, and several spots may become confluent, thus covering a large area of the tuber. The outer layers of the skin are killed by the fungus and take on a different colour from the healthy skin. Owing to the silvery sheen of the dead skin, and to the fact that it dries up and peels off readily the disease has been given the appropriate name of "Silver Scurf." In many cases, there is present, in addition, on the surface of these silvery spots small black specks which are just visible to the naked eye. These are the "sclerotia" of the fungus, that is, each consists of a dense mass of closely interwoven fungus filaments, and by means of this the disease is reproduced.

If a tuber affected with Silver Scurf be washed and kept fairly moist for a few days the surface of the silvered spot appears as though a very thin layer of soot were dusted over it.

Summary of Controls Recommended.

By Spraying:—Late Blight, Early Blight and leaf infections.

By Treating Seed:—Common Scab, Rhizoctonia, in slight cases.

By Selection of Seed:—Common Scab, Rhizoctonia, Blackleg and Fusarium Wilt.

By Roguing:—Rhizoctonia, Blackleg, Fusarium Wilt, Leaf Roll, Curly Dwarf and Mosaic.

With regard to the work which we are endeavouring to do along the lines of disease work at the present time, potato inspectors are endeavouring to show the farmers of the Maritime Provinces the above symptoms of diseases, and also from actual experiments carried out in various districts what can be done by spraying. Last season we carried on experiments in many sections of New Brunswick with spraying and in every case had increased yields from spraying of from 50 to 100 bushels per acre, showing them on their own farms how Late Blight and other diseases may be controlled even in bad seasons.

THE WHITE PINE BLISTER RUST IN CANADA

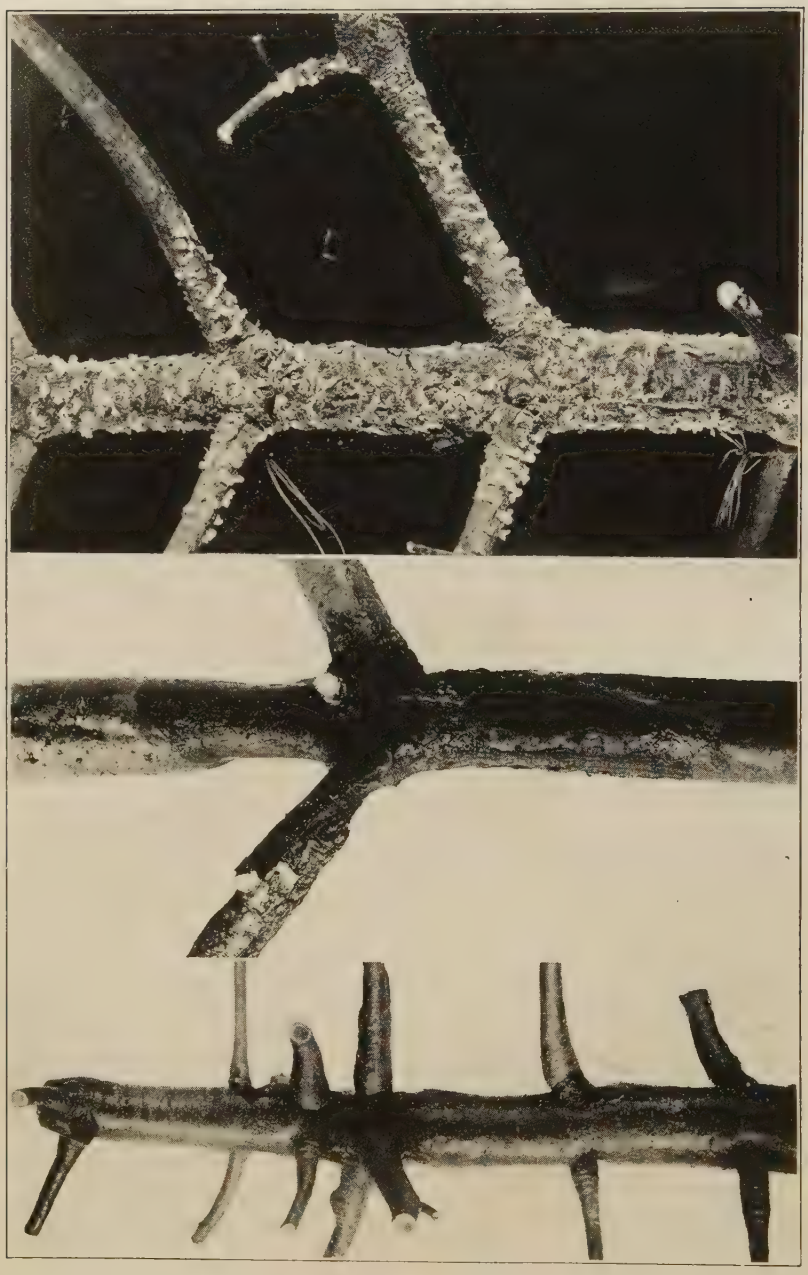
W. A. McCubbin, Dominion Field Laboratory of Plant Pathology, St. Catherines, Ont.

During recent years there has been a wonderful increase in the exchange of commodities of all kinds between parts of the world which were formerly more or less isolated from each other, and among the innumerable articles that are thus freely passing back and forth across the world are large numbers of seeds, bulbs, seedlings, and nursery plants. The readiness with which insects and fungus diseases can be carried on these seeds and plants, and thus become established in a new country, has been increasingly evident; so that nearly all progressive countries now find themselves compelled to adopt strict quarantine methods in order to protect themselves from the virulent diseases of other nations, or of other continents. In Canada we have already learned by several unfortunate experiences that it is far more profitable to keep a disease out than to attempt to eradicate it after it has become established within our borders, and as time goes on, and fresh dangers of the same kind appear, the value of learning this lesson well is becoming more and more apparent.

Among the latest nuisances that have been imported here from other lands is one that hails from Europe, where it has been a well known pest for many years. It is the White Pine Blister Rust (*Peridermium strobi Kleb.*) As the common name indicates, it is chiefly noted as a fungus parasite of the white pine (Pinus strobus L.) but it can also attack several other species of pines, viz:—*P. cembra*, *P. monticola*, *P. excelsa*, *and P. lambertiana*, and perhaps any or all of the thirteen species of five-leaved pines. It may be noted in passing that the five-leaved pines alone are susceptible, and that the two- or three-leaved species, including the Austrian Pine, the Scotch Pine, and the Jack Pine of our northern forests, are not subject to the disease.

The most serious phase of injury from this disease on the White Pine occurs in the seedling stage. It is believed that the fungus gains entry by some wound in the twigs or branches, and from the point of entrance it grows rapidly up, down and around the branch in the soft outer bark. In a short time the branch or stem is girdled and the part above the affected area dies. The presence of the fungus in the tissues causes a considerable swelling of the limb, and this swelling often takes on a sickly yellowish appearance. Once established the fungus progresses down

White Pine Blister Rust—the stage on black currant leaves.



White Pine Blister Rust.—(*a*) early stage of the disease on a pine seedling; (*b*) Later stage on a young pine showing complete girdling of the stem. (*c*) An affected pine limb in spring, covered with the rust blisters. Above this rusted section the limb is dead.

the branch or stem year by year. Each spring there arise from the swollen discolored tissue invaded during the previous year numerous pale orange or whitish blisters filled with countless spores. It may take a branch infection on a large tree a long time to kill the tree, but on the other hand seedlings are killed very quickly, and as seedling trees are more susceptible to attack, it may be seen that in or near an affected grove the seedlings on which future forests depend would have little chance of surviving.

Like many other rusts this fungus passes part of its life on another host—the Currant, or to speak more correctly, on all species of the genus Ribes. Of these species, which include all the wild and cultivated currants and gooseberries, the common garden black currant is by far the most susceptible. On the red and white varieties, on gooseberries, and on wild currants comparatively little damage is done, but black currants suffer so severely at times that the disease promises to become quite a serious pest in black currant plantations.

The spores shed by the blisters on the pine in the spring are not known to be capable of infecting other pines again, but they readily infect nearby currants. The leaves *only* of the currant plant are attacked, and ten to fifteen days after infection there appear on the under sides of these leaves small pustules of a brilliant orange color, and filled with orange spores. These spores in their turn are carried by the wind to other currant leaves and thus the currant infection is spread throughout the summer. So rapid is the spread of the disease by means of these spores that where currant plantations are numerous in a district all the black currants for several miles around the infected pine may be rusted before the end of summer. Although the spores produced in the early part of summer on currant leaves are incapable of reinfecting pines, yet towards the close of the season the pustules put out small orange finger-like growths on which spores are formed that are able to infect pines again; and since as noted above the rust may spread on currants for several miles, there is every danger that a new lot of pines may be infected a long distance away from the original pine from which the currants received their infection in the spring.

So far as we yet know, the rust on the currants dies out each winter, and infection has to start each spring from some blister canker on a pine in the neighborhood. I would say, however, that several circumstances arose during the course of our observations on this rust last summer, which give grounds for suspecting that in exceptional cases the fungus may overwinter on the currant. If these suspicions should finally be justified, the problem of controlling the disease will be much complicated.

We have here, then, a disease, the life history of which may be summed up as follows:—

(A) On the pine.

1. Lives on 5-leaved pines only.

2. Produces cankered areas with discolored swellings in limbs.

3. Limbs are girdled and killed; seedlings are killed rapidly; adult trees more slowly.

4. Spores produced in early spring from the canker blisters may infect nearby currants, but not pines again.

(B) On Currants.

1. On all wild and cultivated currants and goosberries; black currants particularly susceptible.

2. Leaves only affected; small orange rust pustules on the under sides of the leaves.

3. Spores from these pustules spread the disease during the summer to other currants (but not to pines).

4. In fall spores capable of infecting pines appear on the leaves.

5. Rust probably dies out each winter on currant and has to be started in spring from pines again.

It is well established that the Blister Rust was brought to this continent from Germany, Holland and France, on white pine seedlings imported for nursery purposes. Both in the United States and Canada numerous infections in different districts have been definitely traced to some seedling pine affected by the disease, and either standing in the nursery row or planted out in shrubberies or forestry plots. In only one case in Ontario has the disease been found on native grown white pines, but the amount of infection in the small woodlot in question was so great that it makes one shudder to think of what would be the result if the disease ever gained a footing in our large forest areas.

So far as I know there is none of the disease outside of the Province of Ontario. In that province the affected area includes, generally speaking, the fruit district between Niagara Falls and Hamilton, and extends along the northern shore of Lake Ontario between Toronto and Hamilton as far as Oakville. In addition there are isolated areas at Brantford, Guelph, Dutton (Kent Co.), and Bowmanville (Durham Co.).

Judging from the experiences of the U. S. Forest Service in stamping out the disease in a number of areas in that country, we may not find

White Pine Blister Rust—(*a*) normal condition of healthy black currant shoots on Oct. 3; (*b*) rusted shoots taken on the same day. They have been long defoliated by the rust and a new set of leaves has been formed by premature development of the winter buds. As all these secondary leaves will die in winter the effect on the plant is very harmful; (*c*) spraying for currant rust. The two rows on the left were unsprayed, and were defoliated early. The two on the right were sprayed eight times with Bordeaux mixture. While not entirely rust-free, they kept their leaves till the normal time of leaf-fall.

exceptional difficulty in eradicating the Blister Rust from the isolated areas mentioned, but in the case of the main district containing over 300 sq. miles of territory, the problem promises to be extremely hard to solve. Not only are there thousands of small and large currant plantations throughout this Niagara region, thus permitting the rust when once started on currants to sweep over miles of country, but there are as well immense numbers of half-grown and seedling pines scattered about the whole section, all exposed each summer to wholesale infection. It would be almost miraculous if there are not now established thousands of pine infections each capable of starting an epidemic of the currant rust.

The method of fighting this disease which has been heretofore used consists of careful surveys to locate the infected pine or pines, and the immediate destruction of these when found. In isolated areas where either pines or currants are few this method can be depended on to give results, especially when it can be continued year after year without much danger of the spread of infection because of the fewness of either host. In the case under consideration, however, the inspection of the immense number of trees in the affected district would be a stupendous task, and even with the most careful inspection the location of more than 90% of the blister cankers would be a virtual impossibility. If currants were scarce and far from each other perhaps the disease could be reduced in successive years in this way and finally eliminated, but the presence of so many currant plantations in close proximity to each other allows the 10% of cankers remaining to start just as much rust as if the whole lot were left.

Spraying the currants has suggested itself as a means of fighting this disease. We have given this phase of the subject some attention during the recent summer, and have experimented with two fields in the affected district. One of these was sprayed with Bordeaux mixture and the other with soluble sulphur, both at intervals of two weeks, throughout the susceptible part of the season. It was realized that the spray would have to be applied to the under sides of the leaves, and though this was done as thoroughly as possible in our work, it must be admitted that it takes so much time and care that effective spraying of this kind would be almost out of the question in a commercial way. Owing to frequent rains during the summer we did not get the best results from our work, but even allowing for this we are certain that though the amount of the rust can be greatly reduced by spraying, it cannot be controlled sufficiently to prevent the spread of infection. Consequently whatever value spraying methods may have as a means of protecting individual plantations, they are likely to be of little use in combatting the disease as a national pest.

There is still another cause for alarm in the situation. Millions of fruit packages are sent out of this district each year, and great numbers of these carry to uninfected districts the spores of the rust. We cannot say yet just how long these spores retain their power of infection, but if it is even so short as a few days, there is constant danger of the disease being spread into other parts of the province. For this reason a yearly inspection of the whole province will probably be found necessary until danger from this source has been eliminated.

I do not know of any case of the Blister rust in the Province of Quebec and I sincerely hope that the disease will never gain a footing here. Since this province, however, has been subject to the same chances of infection that we have had in Ontario, I would strongly recommend that adequate steps be taken to see that there is no area of infection anywhere within the boundaries, if this has not already been done. This precaution is all the more valuable now since all danger of future importations of the disease has passed away owing to the regulation prohibiting the entrance of all European pines liable to the disease.

INSECT NOTES, 1915

E. Melville DuPorte, Macdonald College.

There were several more or less severe outbreaks of injurious insects during the season of 1915 at Ste. Annes and the surrounding country. Attention is drawn to the more important of these.

Insects Affecting Grains and Clovers.

The frit fly (*Oscinis carbonaria*) and the wheat stem maggot (*Meromyza americana*) caused some injury to the small grains. The Hessian fly (*Mayetiola destructor*) was observed by Mr. L. C. Raymond to be injuring the wheat of the experimental plots at Macdonald College. I have not found any reference to previous injury by this insect in this neighborhood. It was almost certainly introduced in manure from the stock yards, because the plots most injured were adjacent to the manure pile.

The chief insects attacking the clover were the Clover Seed Chalcid (*Bruchophagus funebris*), the Lesser Leaf Weevil (*Phytonomus nigrirostris*), the Clover Mite (*Bryobia pratensis*), the Pea Aphis (*Macrosiphun pisi*) and the Clover-head Weevil (*Tychius picirostris*). The clover chalcid is a small four-winged fly, the larva of which feeds in the developing clover seeds and is one of the most serious enemies of the seed crop. It has been very abundant in the Montreal-Ottawa district during the past three seasons, last year perhaps not quite so abundant as in the two previous years.

Another enemy of the clover seed is the larva of the Lesser Clover Leaf Weevil. This feeds in the flower heads, destroying the florets and last year was generally present in the neighboring clover fields.

The clover mite was most injurious during the latter part of the season.

The clover insect to which I desire to draw particular attention is the one which I have termed the Clover-head Weevil (*Tychius picirostris*). This is a small curculio about one-tenth of an inch long and of an olive green color. This colour is caused by scales which are borne on the wing covers and thorax of the insect, and when these scales are rubbed off the bare nsect is dark brown in colour.

In May 1915 I noticed these insects feeding gregariously on the leaves of red clover and doing considerable injury. When the clover came into bloom the weevils deserted the leaves for the flower heads, on which they

remained until the end of September, when they left the clover plants to hibernate as adults in lumps of manure and vegetable matter beneath the soil.

The insect has been introduced from Europe. It has been collected at Framingham, Mass., and at Ithaca and Oswego, N.Y. It has, however, not been recorded as a pest in America before, and Dr. Marshall, the Director of the Imperial Bureau of Entomology, tells me that he can find no European references to it as an injurious species.

The insect is undoubtedly a potentially injurious one, but whether it will be a permanent pest or will only flash into significance intermittently it is impossible to say at present. I have collected it every year since 1912, but not until last year was it present in sufficient numbers to be regarded as injurious. Next season observations on the insect will be continued for the purpose of collecting further data on its life history and habits.

Locusts. The locust outbreak was very severe in the province of Quebec during the season of 1915. Grain, hay, root crops as well as garden crops were attacked. In most parts of the province the species most abundant was the Lesser Migratory Locust (*Melanoplus atlanis*); in the neighborhood of Ste. Annes, however, the Red-legged locust (*M. femur rubrum*) was the most abundant species. The striped locust (*M. bivittatus*) as well as some other forms in lesser numbers also did some injury. The poisoned bran mash (Kansas formula) was used to protect the experimental root and grain fields at Macdonald College. This was not quite as effective as expected and considerable injury occurred after its application, owing probably to the fact that the locusts migrated from the neighboring untreated fields. This fact emphasises the need of co-operation among farmers in the control of this pest and others similar to it.

Insects Attacking Field and Garden Crops

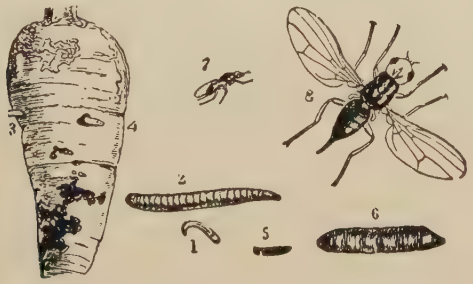
Cutworms. Another very serious outbreak of cutworms occurred in parts of the province, resulting in considerable loss to growers of field and garden crops. The species causing most injury in the Montreal district was the Striped Cutworm (*Euxoa tessellata*). These insects were attacked by several parasites and the number of moths observed was quite small in proportion to the number of caterpillars. It is therefore probable that there will be less injury next season.

Root Maggots. Cruciferous crops suffered heavily from the attacks of two similar maggots, the Cabbage root maggot (*Chortophila brassicae*)

The clover-seed chalcis, *Bruchophagus funebris* How. Adult female greatly enlarged. (After Webster).

The Striped Cutworm—*a*, lateral aspect; *b*, dorsal aspect—one-quarter enlarged. (After Gibson).

Moth of Striped Cutworm, *Euxoa tessellata*—natural size. (After Gibson).



Carrot Rust-fly—1, 3, 4, 5, 7 natural size; 2, 6, 8 enlarged.

and the Seed Corn maggot (*C. fusciceps*). The Carrot Rust Fly (*Psila rosae*) was the cause of much injury to carrots.

The **Beet-Leaf Miner** (*Chortophila vicina*) was very abundant on mangels, beets and spinach. Complaints were received from various parts of the province where this insect was reported as causing much injury.

The **Hop Flea Beetle** (*Psylliodes punctulata*) was injurious to beets and mangels at Ste. Annes. The insect causes great loss to hop growers in the west where it also attacks several other crops. This is the first record of injury by this insect in the province of Quebec.

The **Parsnip Web Worm** (*Depressaria heracliana*) gained prominence as a pest last season owing to the fact that parsnips were grown for seed here for the first time. The caterpillar is greenish yellow above and lighter beneath, and bears numerous setigerous black spots. It usually enters the developing flower heads where it constructs a nest and feeds on the flower buds, seeds and young leaves. It has been present on wild parsnips in the neighborhood of Ste. Annes for years but it did not before invade the cultivated fields, owing to the fact that no attempt had previously been made to produce parsnip seed.

Insects Attacking Fruit

The **Bud Moth** (*Eucosma ocellana*) has been for several years one of the most injurious apple tree insects in the province. It was again abundant last season. Experiments were carried on last year on the control of this insect and the results showed that the best two-spray combination was the second and third sprays of the ordinary spray calendar, i.e., a spray applied three days before the opening of the petals, and one shortly after the petals fall.

An interesting example of the value of parasitic insects was observed last season when the Minute Chalcid Fly (*Pentarthron minutum*) practically controlled the Plum Slug (*Eriocampoides limacina*). This pest was quite injurious during 1913 and 1914, and the number of eggs laid in the spring gave promise of a similar destructiveness in 1915. The eggs, however, were so effectively parasitised that it was not necessary to spray specially for this slug.

Other insects very abundant in some neighbouring orchards last year were the Apple Maggot, the Cigar Case Bearer, and the Buffalo Tree Hopper.

The most important pests of small fruit were the Currant Saw Fly, the Raspberry Saw Fly and the imported Currant Borer.

A PRACTICAL METHOD FOR THE PROTECTION OF PLANTS

P. Fontanel, S. J., St. Mary's College, Montreal.

The title of this paper may be misleading but I have not been able to find one more appropriate. I trust, however, that its meaning shall be clearly understood as I proceed.

I had intended at first to treat of the little beings that eat up millions every year, but after serious reflection I decided to leave such matters to more competent students of Economic Entomology and Botany.

As a matter of fact, the study of insects and fungi, their life and evolution, is an excellent one and has already been partially accomplished; the study of plants, their needs and diseases, is not less excellent. As this work is being done regularly by specialists, little by little, working hand in hand, we shall have it completed. While we are studying, however, caterpillars are eating up the leaves and worms are boring deeper and deeper. We know what means should be employed against a large number of insects, but who of us shall go into the battle field. Our daily tasks make this impossible. And while we are widening our range of knowledge, the foe is rapidly increasing in countless numbers. Who, then, shall fight? Will those really interested, the victims, ever even know that we are thinking of them? They, and they only, can effectively destroy the insects and hinder the development of the fungi if they will. They will no doubt desire to do this but what do they know of this branch of science? For every one possessing some knowledge in this matter you will meet a thousand woefully ignorant. It is only right then that they should be instructed and the sooner this is done, the better.

But they will not come to us; we must go to them. The old will be reached with difficulty, the young will be found in the schools. It has been my experience that from the Natural History standpoint our youth behave as if they were totally deprived of the sense of observation. At their sports and amusements they notice everything, forget nothing, but if there be question of plants or insects their eyes seem to lose all their keenness, their brain its attention and memory. In my humble opinion, the fault should be imputed to the education received. The mind is not trained, not urged on in this direction and consequently remains inactive. Should we not come to their aid? When grown up they would be our best friends and co-workers.

It would be necessary, then, to trace out a plan of education and put it into execution. With this end in view I most humbly submit for your consideration the following outline of a programme that might in some measure solve the problem in question. I have divided it into three parts, namely: I. Books; II. Illustrated lectures; and III. Collections.

I. Books

Our society should prepare a list of the different works treating the subjects in which it is interested and send a copy of this list to all the schools of the Province, both English and French. Even if the pupils could not profit by this directly, still the teachers availing themselves of the information it contains could impart this knowledge to them. Let us bear in mind that teachers have a powerful influence over their pupils and that they can teach only what they know. Now, it cannot be denied that a large number of teachers ignore the very existence of those scientific branches which concern the life of plants. On the other hand it will be difficult for us to teach them: more than one would refuse to listen to us, as many prefer to learn themselves. Hence the necessity of making known to them the works that can help them.

One of the main efforts of our Association should be to remedy the want of popular books treating of agricultural plants and animals. That there is a need of such, no one can deny. The few works of this kind that exist, being for the most part reports or writings of specialists, containing but few illustrations, offer little attraction for the uneducated. Why not get up well-illustrated books with attractive bindings appealing to the aesthetic sense in the young? These books could be sold cheaply and distributed as prizes in the schools at the end of the year. This would be a means of introducing into country homes in an attractive form a science which is indispensable to every farmer.

Works of this kind already exist in several countries, especially in France and Germany. Last year a number of these were given as prize books in one of our colleges and I have proofs that they have been appreciated. Some of these books are not practical for Canada as the questions dealt with have reference to the country where they were written. We should prepare books of this kind answering to the special needs of our own population.

All I have said might be summed up as indirect personal education. It would be necessary, as we have seen, to make known the works that already exist, to publish new matter, and publish under a more attractive

form. If the suggestion seems good I would recommend two practical means for its realization.

1. That all the members of the Association be requested to make a list of such books as they may judge fitting to the end aimed at, keeping in mind that Canada, and the Province of Quebec in particular, is the field to be studied. These lists to be handed in to a member or to a committee charged with classifying the different works. This task accomplished, a kind of catalogue would be printed and a copy sent to the various schools. The members of the Association themselves would thus profit by the knowledge of the others and would know where to seek information when needed. It would, besides, be a means of ascertaining the extent of ground already covered, and the work yet to be accomplished in the pursuit of our common end.

2. That no time might be wasted, the members who would decide to write instructive and interesting works for the uninitiated would make known to the President, at the beginning, their subject and plan. Being thus kept in touch with the efforts of each, he could render valuable assistance in the distribution of labor over the different fields.

II. Illustrated Lectures

Both old and young, even if educated, will profit more by illustrated lessons than by dry lectures. I will divide into two parts what I have to say on this subject of the preparation of slides and lectures.

A. The Preparation of Slides

We should prepare a series of slides, as complete as possible, three slides of each. This number I think would be sufficient, though as many as five might be prepared. These slides would be placed at the disposal of those who desire to give lectures. Three centres would be chosen in the Province, at each of which would be placed a complete set of the slides. Lists of the subjects would be printed and those desiring to give a lecture would simply have to write to the nearest centre asking for the subjects required. The transportation charges, as well as damage from breakage, etc., would be paid by the borrower. Outside of this no expense would be incurred for the loan of the slides? And here a practical question comes up: who would pay for preparing the slides. It is my opinion that the government would willingly do this, especially as the slides in that case would remain its property. I believe that by special arrangement the expense

need not exceed 10c. for the negative and 10c. for each positive, which would mean 40c. for each slide, $4 for 10; $40 for 100; $400 for 1,000. There is here nothing exorbitant, surely.

In practice this is what I should advise:

That there be a member or a committee intrusted with collecting prints, drawings, photographs; in a word, whatever may furnish a good subject for a slide. The members of the Association would be invited to co-operate in furnishing drawings and photographs of their experiments and observations.

That this member or committee arrange with some photographer, or other person, one or several, to have the negatives and positives made. Really skillful amateurs could often be found ready to render very appreciable services and the same may be said of professors of sciences in many colleges. Many institutions and professors would gladly loan negatives.

The slides would bear a number and title and would be classified in numerical order. This would prevent much misunderstanding and save time in correspondence. After a time a complete list would be published, then, every six months or every year, according to the work accomplished, a supplement would be issued.

B. Lectures

Not alone would the members of the Society be called upon to give lectures, but all friends of plants, all professors and teachers. The slides being at the disposal of all, and the lantern being a means of instruction greatly enjoyed by the young, many teachers would avail themselves of this means to interest their pupils and in order to impart instruction to these would study up the matter themselves.

What would be the role of the members? Each one could, according to his will, according to circumstances, give lectures, and it is my opinion that they would often be invited, since the professors of all the schools would know their willingness to lecture. But they could do yet more, and better: prepare lectures at least in outline, indicating, as they proceed, slides having reference to the matter treated. This is the kind of lecture that many teachers would gladly use to teach their pupils.

The subjects could vary infinitely, the principal divisions being the following: the useful plants and the noxious plants of the Province; the animals useful to plants and those harmful directly or indirectly; the insects and the fungi fighting for or against plants; the weapons of defence supplied by modern science.

In a word, the role of the members would be to give lectures, prepare, or at least gather up and classify, material to be placed at the disposal of those desiring to instruct the young.

This is what I would advise in practice:

To fix the boundary of the field to be covered as exactly as possible, which work would be of great advantage in preparing the slides. It would be necessary to have a complete and detailed programme.

The members desiring to give lectures would choose their subject and treat it as they saw fit: those who wished to prepare plans of lectures and gather material would do well to make known their subject to the President, giving him the chief details. In this manner it would be easy to prevent the possible incongruity of several writing on the same subject.

III. The Collections

Before concluding, I should like to call your attention to this other method of fighting insects and fungi. Our devoted president had already suggested that the Society undertake the preparation of collections for the schools in order to accustom the children to recognize the friends and the enemies of plants. This means is too precious a one to neglect. It is a point more delicate perhaps than the other two and that would accordingly require a special organization: the extension of the collections, the method of classification, all this would require a thorough study. This means would be an immense advantage to initiate the young in Entomology, a study at once so attractive, and alas, so profoundly ignored, not to say despised. Sight helps to recognize the insects; knowing a little the amateurs wish to know more, and at the same time they desire to start a collection; in collecting they observe, they study. Then they impart their knowledge to others and thus the number of the ignorant and the indifferent decreases gradually.

As the question of money plays here an important part, perhaps, and as this is not in my line, I will not insist farther. Before searching for means of doing one must be certain of the possibility of doing. However, I will presume on your kindness to make one more suggestion. In a large number of schools and colleges, professors just beginning, or pupils, would like to make collection of insects or of plants, but from the very start they are often stopped by difficulties: lack of knowledge, of masters, of books. Could we not furnish a kind of permanent committee which would be at their disposal on certain days to identify the samples sent? If the professors or pupils themselves make the collection, whatever be its value, they are interested in it, admire and consult it. If they can have it already made,

just for the asking, they ask it for the pleasure there is in receiving and the satisfaction in possessing it, but it costs them too little to be of any great value in their eyes. I could here name a large number of institutions where official collections rest peacefully in the dust until they are roused by being thrown out of the window. The collection of seeds furnished by the Department of Agriculture at Ottawa, that of rocks and minerals offered by the Department of Mines, likewise at Ottawa, that consisting of 40 minerals given by the Bureau of Mines of Quebec share this fate. They were asked because they cost nothing. On their arrival, they were opened, perhaps they were shown to some visitors. No further use was made of them. Of course this is not the rule but it is far more than the exception: I speak of what has fallen under my personal observation. From this, one easily understands why the authorities sometimes hesitate before voting expenses, the usefulness of which is not evident. Not to go outside Quebec, allow me to quote a few words of the Superintendent of Mines. He had attempted in his department what we wish to do in another, and had bought small collections of minerals to distribute to the schools. Here are his impressions:

"Three years ago.....I had made small mineral collections consisting of 40 specimens and I prepared some very elementary notes on Mineralogy in order to place the preliminary notions of this science within the grasp of children of a dozen years of age. My object was not to have the pupils make a course in Mineralogy, but rather to develop in some a taste for this science. These little collections and their explanatory pamphlets are at the disposal of the schools which ask the Inspector General of Schools for them. Our success so far has been rather negative: I have met with more indifference than encouragement."

I should like to believe that we shall be more successful than he, but my trust is not a decisive argument. For my part, I feel confident that we should do more for the success in view if we could get people interested in collections, in undertaking them, in perfecting these themselves, by placing ourselves at their disposal to help them. If, then, the Government consented to grant us financial aid, I should be of the opinion that these collections be mere outlines, if I may so speak, and an attraction. Those who would not be interested would waste less money; those really interested, knowing our willingness to help them, would push forward of their own accord and as a result their personal profit would be much greater.

Here are many suggestions. I am bold enough to believe them useful, but I leave to your deliberation the freedom of changing, of approving or rejecting them. I think, however, that the principle that has inspired them ought not to be overlooked: in practice, we shall do but little ourselves

in the struggle which we are undertaking. We must denounce the enemies, study them, make them known, find and give means for destroying them. To this is our action limited. The young generations are they who will carry on the fight, and these generations are not sufficiently awake to these vital questions. Let us rouse them, instruct them.

The books will place science within their reach and these, with the illustrated lectures and the collections, are three excellent means according to experience.

In all this there is nothing very attractive for us.....labor devotedness, that is all. As a reward the pleasure of having helped good people, ignoring their possible happiness or the cause of their unhappiness. None of us has entered this Association with the hope of becoming a millionaire nor to make a name for himself. We have entered it in order to help our neighbour. For my part, I am determined to do my share giving myself to this work without reserve in so far as my other duties will allow.

THE BLACK KNOT OF PLUM AND CHERRY

C. B. Hutchings, Macdonald College

(*Plowrightia morbosa, Schwtz*)

The purpose of this paper is to discuss briefly the Black Knot disease of Plum and Cherry from various standpoints, viz:—its history, distribution, appearance, effect on host and its control.

Black Knot is a very serious and widely distributed disease of the different species of Prunus. It is characterised by the dark, unsightly, wart-like excrescences which appear on the twigs and branches of the host, giving them the appearance of being burnt or charred. It is very noticeable in small gardens, neglected farms and wayside places. Where allowed to remain unchecked the disease will rapidly spread throughout the orchard, and in a few years ruin it. If, however, the trouble is taken in hand when it first appears, it can be easily checked and in time eradicated.

There are records which show that this orchard pest was noticed as far back as the beginning of the 19th century, but the trouble was not carefully studied until about 1870. Since then little has been done.

Black Knot is found very abundantly throughout Great Britain, the United States and Canada, wherever plums and cherries, wild or cultivared, are found growing.

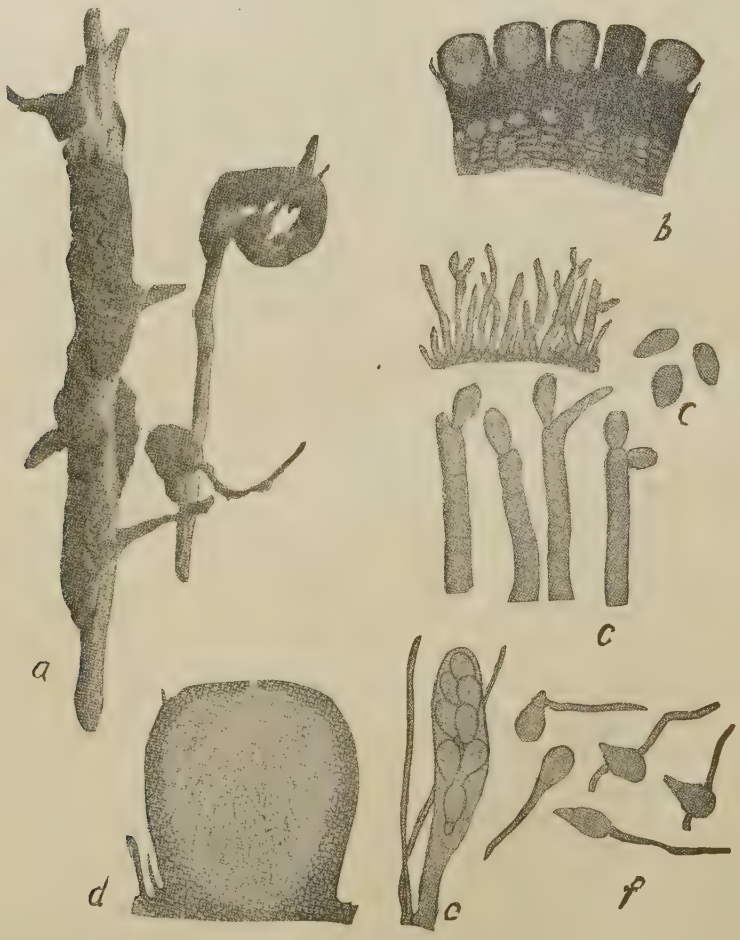
It is particularly bad in the Maritime Provinces, Quebec and New York State, and in parts of Ontario. In the Niagara peninsula where the majority of the cherry and plum orchards of the Dominion are situated, control measures are so carefully carried out that the disease is almost unknown.

Excepting the wild pear (Amelanchier) upon which it has been reported, the fungus is confined to the various species of Prunus, and may be found on nearly all varieties of both the wild and cultivated. It appears , however, more disposed toward cherries of the Murillo type, and plums of the Damson variety. It has also been noticed that the disease will attack, in certain seasons only, *certain* species of plums and cherries and neglect others. This is due possibly to the fungus having several physiological or biological forms which restrict themselves to their respective hosts. This matter, however, has not been definitely settled.

The disease attacks only the woody parts of the host. Usually the Knot does not entirely girdle the branch but appears on one side, extending

up and down the branch for several inches. The smaller branches and twigs it generally girdles, stopping the flow of sap and leaving them often badly distorted and dead.

The disease, as a rule, appears in the spring in the form of a slight yellowish swelling. This generally takes place at some junction of the limb or at a notch in the branch where spores have found a convenient lodging place. As the swelling increases, the bark cracks and the parts affected become coated with a soft, velvety, olive-green mass—the summer



Black Knot Fungus—*a*, mature knots on plum branches; *b*, magnified section of a knot showing the spore cases; *c*, spore stalks which grow on the surface of the knots when young and give rise to summer spores; *d*, section of a winter sporecase more highly magnified, showing numerous contained spore sacs, one of which is shown very highly magnified at *e*; *f*, several of the two-celled winter spores germinating in water. (After Longyear).

spores which ripen and become liberated about May. A little later on, a second crop of spores is produced. This mass darkens and the entire surface becomes quite black and charred in appearance. These are the winter spore cases. They become fully developed about mid-winter and shed their contents at the end of the winter or early the next spring.

The life history of the fungus is as follows:— When a spore becomes liberated and finds a favourable germinating spot, it sends down a tube through the epidermis of the plant into the cambium and bast areas, thence to the cortex. Here the mycelium is abundantly produced and the cell walls, tissues and vessels of the host are broken up in great disorder as a consequence. The mycelium then finds its way to the surface through small light green spots, tearing and breaking up the bark as it goes and exposing the abnormal tissue of the knot beneath. From this covering arise the summer spore-bearing bodies, in thick, compact, velvety masses. They are upright, slightly curved at the tips and may further become branched or bent as the brown spores are formed at or near the tips. After these summer spores ripen they are blown away to other branches, where they germinate, if conditions are favourable. This stage of the disease lasts until about mid-summer when very small, black, pimple-like bodies begin to appear among the green velvety masses of summer spore cases. These are the winter spore cases and contain very large numbers of the winter spores. The spores ripen towards the end of the winter or early spring, when they are shed from their black cases and infect other branches and twigs.

The control of this disease is not a difficult one. Careful pruning and burning of all knots before they reach maturity is considered the simplest and most efficient means of dealing with the Black Knot.

A good method of control is to spray the trees with Bordeaux Mixture or lime sulphur towards the end of the winter and again as the buds show signs of swelling. Then follow this with two or three later sprays. Mr. Gussow, Dominion Botanist, in his 1911 report, considers that spraying for Black Knot is hardly a paying proposition. Cornell Exp Station, N.Y. State, on the other hand, reports that it is profitable and publishes a bulletin, No. 81, as the result of experiments conducted there, to show a reduction of Knots from 2,000 to 165.

Mr. McCubbin, Plant Pathologist at St. Catharines, Ont., in a bulletin, No. 24, reports Bordeaux Mixture, various chemicals, tars, and paints, all good controllers.

In cases of bad infestation, the wisest and best method is to cut the trees down and burn them.

Another method of control, or rather prevention, is to keep the trees healthy by thorough and clean cultivation, since it has been found that vigorous trees are less susceptible to attack; and also to remove any wild varieties of plum and cherry that may be in the neighborhood. Nothing, however, has been found so effective, so easy and so economical as good sharp pruning tools. These used freely with a reasonable amount of intelligence will readily and efficiently control all cases of the Black Knot of plum and cherry.

THREE INJURIOUS ACRIDIANS OF NOVA SCOTIA

C. B. Gooderham, Macdonald College

Among the many species of Acrididae or Shorthorned Grasshoppers, there are three forms which are very common in Nova Scotia. They are usually found together, causing a considerable amount of damage to hay and grain crops. To the casual observer these three forms look very much alike, but upon close observation they will be found to differ considerably.

In this paper I will attempt to describe each species briefly and to give a short key for their separation.

Key for Separation.

A. With prosternal spine between front pair of legs.

B.—Prosternal spine pointed, cerci short with length not more than twice their width at middle. Subgenital plate of male with a median notch. Hind femora usually crossed with dusky transverse bands. Median carina on prozona seldom distinct. —*M. atlanis.*

BB.—Prosternal spine bulbous or rounded. Subgenital plate of male without median notch. Distal half of cerci less than half as broad as at base. Hind tibia red, hind femora without dusky cross bars, median carina frequently distinct on prozona.—*M. femur-rubrum.*

AA.—Without prosternal spine. Disk of pronotum flat, median carina low, equal throughout, faintly cut by principal sulcus. Hind femora crossed by three more or less distinct black bars.—*Camnula pellucida.*

The Lesser Migratory Locust

(*Melanoplus atlanis* Riley)

Size medium. Vertex somewhat elevated above the pronotum, front half strongly sloping. Pronotum rather short expanding at metazona, front margin quadrate, hind margin obtuse angled, disk slightly convex, median carina only distinct on metazona. Tegmina fully developed and surpassing the hind femora, both in male and female, usually spotted with

black or dark brown spots. Hind femora yellowish with three oblique dark bands on upper and outer faces, more distinct in male than female. Cerci about twice as long as broad, apical, half slightly upcurved and apex rounded. Subgenital plate of male narrowing regularly from below upwards, upper edge somewhat thickened and with a distinct median notch. Furcula consisting of a pair of slender tapering spines.

Members of this species are very abundant, especially on dry barren lands where vegetation is scarce. Color is either a dark greyish or reddish brown. There is a dark band behind each eye reaching to the metazona but not extending on it. In the female this band is broken into spots.

This insect is abundant from mid-June till late fall, when the eggs are laid; these hatch in the following spring.

The Red-legged Locust

(*Melanoplus femur-rubrum* De G.)

This is known as the common Red Legged Locust, and is found almost anywhere in the Eastern provinces. It is often confused with the M. atlanis but the key will aid in separating them. Vertex but little elevated above the pronotum, front half strongly sloping. Pronotum slightly expanding on posterior half, disk nearly flat and crossed with three sulci, hind margin obtuse angled more so in female than male, front margin quadrate, median carina visible throughout but more so on metazona. Tegmina gradually tapering and slightly surpassing the hind femora, brownish in color, often without darker spots. Cerci tapering rapidly from base to middle, then subequal to apex which is slightly incurved. Furcula consists of a pair of long tapering spines. Subgenital plate of male short apically, apical margin not elevated, strongly rounded, broad, truncate. Hind femora brownish and usually without any dusky cross bands, hind tibia red and armed with black spines.

There is great variation in color in different localities and at different seasons; the usual color is reddish brown.

Eggs are deposited in the fall and hatch the following spring. Adults are found from June till late fall.

The Clear Winged Locust

(*Camnula pellucida* Scudder).

Head slightly compressed, vertex with its disk subtriangular, front half sloping downwards. Pronotum with its disk flattened, front margin truncate, narrower than the hind margin which is obtusely angulate. Lateral carina distinct, median carina distinctly elevated and of same height throughout and cut in front of middle with small notch. Lateral lobes deeper than long. Tegmina with apical third reticulate and surpassing the abdomen. Inner wings transparent.

The color is somewhat variable but is usually of a light brown. There is a dark triangular spot behind each eye and an oblong, vertical, black spot on front half of lateral lobes of pronotum. Tegmina brown with several large, dark spots scattered over them. Dorsal surface brown with a yellow stripe running down each humeral angle. Hind femora brown and crossed by two or three oblique black bands on outer face.

This is the most common of our species and is found mostly on uplands and pastures and often does considerable damage. It is our earliest grasshopper. As in other species the eggs are deposited in the fall and hatch the following spring.

There are many other forms present in our province but none of them is as injurious as the three above mentioned which seem to go together, for if one of them is found, a little searching will soon discover the other two. These three species are also found commonly in the Province of Quebec.

OLD AND NEW METHODS IN WEED CONTROL

P. I. Bryce, Macdonald College

What is a weed? This is a question that cannot be perfectly answered. We all know some weeds, and most of us presume that they are always weeds. Whether that be so or not, need not concern us; it is quite sufficient if a plant be growing to the injury of the crop in which it is found, then it is a weed.

Losses due to Weeds.

Weeds are not only useless, but may be definitely injurious to man and beast. Some act as specific poisons, such as the poison hemlock. Some of the most poisonous plants in our range include purple cockle, poison ivy, water hemlock, the nightshades and ragwort (*Senecio jacobea*). These should be known to all stockmen, in particular the ragwort which produces fatal disorders in cattle. The roots of water hemlock are deadly to cattle if eaten in quantity. Purple cockle darkens and poisons flour, as the seed is next to impossible to separate from wheat. While not poisonous, thorny or barbed plants injure live stock. Among these hurtful plants, squirrel or skunk-tail grass has bristly awns which pierce the gums and cause inflammations. Russian thistle causes trouble in wheat fields in the West, by injuring the legs of horses drawing binders etc.

Losses in yield are a much more serious result of weeds. They seem to have harmful effects on the crop. It may be that this effect is due to substances given off from the weeds, and poisonous to crops. Such actual loss to the crop was estimated in Minnesota to mount up to 40 bushels per acre. Where 60 bushels should have been harvested, only 20 bushels were threshed out. The general result of the presence of weeds is the crowding out of the crop, while weeds shade it and keep the leaves from evaporating enough water to make the proper amount of food. In dry seasons, the weeds use up too much of the available moisture. The U. S. Department of Agriculture has estimated the loss due to weeds in crops and meadows at $1.00 per acre.

Another injury from weeds is increased harvesting cost. Weedy hay takes longer to cure. Weedy grain uses more binder twine and extra work is required of the horses to cut the grain. "Russian thistle, bindweed, and Canada thistle are usually a source of great annoyance at harvest

time to the growers of small grains." (Cox, 11.) When the diminished crop has been harvested, at too great an expense, the loss has only begun to show. Weed seeds are as expensive in the threshed-out seed as are the weeds to the growing crop. The grain-buyers and graders, the elevator owners, and the millers, are the stone wall into which the poor reckless farmer bumps when he ships his weedy grain, clover or timothy seed. They are the real police, and have power that dwarfs that of the seed inspector; yet they are the farmer's good friends as well. According to Dymond (3) when the grader examined samples representing 25,000 bushels of wheat he found only 92.6% by weight of pure wheat, the remainder was largely weed seeds. This is a bad example, but a car of flax examined showed weed seeds to be 16% of the total weight.

Western grains are graded and "docked," fortunately for the Quebecer, at Winnipeg and Fort William-Port Arthur. Weedy grain cannot be binned with its proper grade until cleaned. The percentage of impurities is deducted and dockage set in accordance with this percentage. It was found that the actual dockage at terminal elevators set by the Inspectors in the year 1912-13 was over 100,000 tons. To haul this cost, at an average of $6.50 per ton, $650,000. From 10 to 20% of the best screenings are shipped to Ontario and Quebec, most of the rest goes to the Unites States. In any case the screenings are a clear loss to the grower. Thus it pays the grain grower to keep down or control the weeds. Even if he grows weeds, there is little reason for shipping them. "The president of the National Association of Thresher Manufacturers of the United States says: 'The manufacturers of threshing machinery of both the United States and Canada are perfectly willing to furnish with each machine a cheat or dirt screen, and with *proper* use of the same the operators of threshing machinery can take most of the shrunken grain, dirt and weed seeds out, so that the grain can be delivered to the farmer practically clean.' Another manufacturer states: 'We have for some years been supplying an attachment to our separators which are shipped to the Argentine Republic, where, I understand, they have no elevators in which to clean the grain.' A grower who owns a threshing machine should fit it with a set of sieves that will make it possible for him to clean his grain more efficiently as he threshes it.....Loss can be avoided if the farmer will insist that the thresher operate his separator so as to clean the grain more thoroughly at threshing time." (3, 38). Here may be mentioned what the government experts advise should be done with screenings. "The finer weed seeds (*black seeds*) in screenings should be separated from the rest and burned. Screenings, after being carefully cleaned over a 1-14 inch perforated zinc screen to remove the fine seeds, make a valuable feed for any kind of stock. They

had better be ground, for horses or cattle. They are a very valuable poultry food." (3, 40).

So much for seed grain. Just as important is it that similar attention be paid to sowing only clean seed of grass, clovers and other fodder or pasture plants. Pure seed can be purchased in small quantities from the experimental farms, from farmers who are specializing in seed growing, from seed centres and farmers' clubs, and from seed merchants who are careful in securing good stock. The names of reliable dealers may be secured from the Cereal and Horticulture Departments at La Trappe, Macdonald College, and other experimental farms.

Further losses from weeds are caused by burs, cockle-burs and tick-seeds found in fleeces. The annual wool clip loses value to the producer, the shearer loses time and the grader has to grade the wool lower. Other losses are unnecessary impoverishment of the soil. Weeds draw on the mineral plant food and nitrogen of the soil, they rob it of moisture, and certainly reduce its market value. Weeds crowd out the crop, or choke it and drag it down. Some weeds are real parasites. Dodder kills clover, alfalfa, and flax. Dwarf mistletoe causes witches' brooms on balsam-fir, and broom-rape lives on clover and tomato.

Still more losses are the result of fungus diseases carried over and harbored by weeds. The fragrant wild plum becomes a menace when it is the host of black knot, plum pockets, or brown rot. Wild mustard may be infested with club root (finger and toe) disease. Other weeds harbor injurious insects.

Control of Weeds

Dominion and Provincial Laws and Organization

The Dominion and the Provinces share in the controlling of weeds. While the laws respecting weeds in the older provinces have been allowed to lapse, or were never enforced, a new spirit is showing itself. Encouragement of agricultural education by the Dominion and the Provinces is having its effect in this regard, though no doubt the pressure of economic necessity is the greatest factor. Public sentiment, plus the notable interest taken by the public carriers, are seeing to it that more careful cropping and the sale of weed-free forage and products are enforced.

The Dominion "Seed Control Act, 1913" is administered by the Seed Branch by means of inspection, and, after due warning, occasional prosecutions for adulterating and misrepresenting seed. The effect is that a greater

number of inspection visits has shown fewer prosecutions necessary. In 1914 inspection increased by 22% and a decrease of 16.5% in violations of the law was noted. The reports of the Seed Branch show that, in larger numbers, the farmers demand and get clean, viable seed from the dealers.

The following notes from the Annual Reports of the Commission of Conservation (7) and the Agricultural Gazette (2) have to do with weed acts of the provinces. Nova Scotia places a law in the hand of municipalities. Each may compel its landowners to destroy weeds. One county makes owners destroy the poisonous ragwort on their land. Another district compels its occupants to get rid of weeds with wind-borne seeds. The Dominion Seed Control Act, 1913, is in force in New Brunswick (1914). The British Columbia government, according to the terms of the "Noxious Weeds Act, 1915," requires all occupants, or the agents of owners, to destroy noxious weeds. Municipal Councils are considered owners of the land within their boundaries. Inspectors enforce this act, in cooperation with the police. The inspector may enter, and destroy noxious weeds, on non-residents' land. Various unoccupied lands cause much trouble. Among the worst weeds are the Russian and Canada thistles, stinkweed, and wild mustard. The Alberta government in enforcement of their "Noxious Weed Act" appointed in 1915 fifty-six provincial local inspectors, and about the same number were employed by municipalities. Each provincial inspector looks after 9 to 20 townships. Farmers must when notified destroy noxious weeds. Prosecutions for violations of the terms of the Alberta Act were reduced from 60 in 1913 to 40 in 1915. The "Wild Land Tax" is having a beneficial effect in securing the interest of absentee landowners. On behalf of the educational campaign being waged, 25,000 weed bulletins have been sent out since 1912. In Saskatchewan, the Weeds and Seed Branch of the Department of Agriculture enforced the Noxious Weeds Act, 1916. The keynote of the work of the Branch is "weed control." The act specifies that each man shall try to the best of his ability to keep his weeds under control. Each municipality must appoint an inspector by March 1st, each year, on penalty of each member of the council being fined $25.00. In 1913 fifty districts employed paid inspectors at salaries of from $700 to $1,000. In so far as possible the inspectors are trained men, acting as Agricultural Secretaries who further cooperative marketing and general agricultural development. Manitoba directs its municipal councils to appoint inspectors by May 1st yearly. The Manitoba act compels landowners and railroads to keep down noxious weeds. Threshing machines must be thoroughly cleaned at each farm after threshing, and sweepings destroyed. Screenings from cleaned grain may not be sold in the province. Weedy crops may be destroyed by an inspector, who may

prevent weedy land being rented after due notice to the owner. Though resented at first, this act now receives general observance and enforcement. Ontario reports tend to show the provincial "Act to Prevent the Spread of Noxious Weeds" is ineffective, not enforced, and virtually a dead letter. This is accounted for by ignorance of the act, and fear that it will not be enforced. In this province there are, however, several organizations assisting in the spread of knowledge of, and sentiment for, weed control. These include the Agricultural and Experimental Union, Farmers' Clubs, and Farmers' Institutes. The district representatives assist in this work. The "Union's" committee on improving the act has made important recommendations urging publicity, organization for enforcement, and the banning of sixteen additional weedy plants.

Passing to the Quebec law of 1909, now in force, we find that on the complaint of any person, and after eight days' notice, owners, occupants and landowners must cut down and destroy noxious weeds on land not in crop. Refusal or neglect to comply may result in a fine of forty cents a day till the ordinance is obeyed. Any person may compel his neighbor to pull wild mustard and daisies, even in a sown field, as soon as the weeds flower. It appears that this law would be quite effective in any community where a strong spirit in favour of weed control existed. Unfortunately, enforcement of the law seems to be entirely optional. It should be imperative on each township or municipality to appoint qualified weed inspectors. Tactful and patient work by them would soon make weed control a less heavy burden.

Quebec is, nevertheless, making progress in controlling the most dangerous weeds. Yet the report of Mr. F. C. Nunnick (7) on the agricultural survey, 1912-13, showed "that practically none may be said to be following a systematic rotation of crops" but, "the farmers practising a rotation were found the more progressive, their farms carried more stock per acre of tillable area than.....where no hoed crops were raised." In some districts the farmers have fanning mills, or can secure their use, and clean their seed before sowing. In other places the farmer's clubs have bought up-to-date machines. In still other districts, the fanning mill is an unknown quantity, many of the farmers have never seen one. The survey, 1914, shows that on 82% of the farms examined couch grass was increasing as a weed, on 51% ox-eye daisy, and on 17% sow thistle.

Successful Methods used in Weed Control

Improved methods of cultivation and farm management hold the solution of the weed problem and of these crop rotation is the outstanding

one. In some cases the weeds will themselves decide the nature of the crops used, but all good alterations in crop help. If they contain both hoed crops and pasture the best opportunity is had to kill those weeds such as pigweed, mustards, or purslane, which thrive in cultivated fields, or in hay, such as daisy, Canada thistle and buttercup. Small grains and hay, then, should alternate with tilled crops.

Annual and Biennial Weeds.

Annual weeds germinate, fruit, and wither in the same season, and when sown with grain and other annual crops, such as roots, peas and flax may cause heavy losses. To sow clean seed, to seed heavily rather than lightly, and to cultivate the growing crop before the weeds gain headway, are some of the most important steps to be taken in dealing with annual weeds. Another vital point in eradication of these weeds is to prevent their setting and ripening seed, and, where possible, cultivation must be kept up as long as possible. The practice of killing weeds by chemical sprays has spread chiefly from the great wheat-growing districts of the U.S.A., those of the prairie states. The spray, usually sulphate of iron (copperas), or sulphate of copper (bluestone), is applied with a power machine of the row-sprayer type used for potatoes. For small patches a practical hand sprayer will be useful; It should be of brass or wood, and of three or four gallons capacity. For grain fields, the traction sprayer or power sprayer is useful, throwing a misty spray. About 75-100 lbs. iron sulphate to the barrel of water costs nearly $1.00-$1.25, and sprays one acre. Chemical sprays, while they do not seriously affect grasses, kill the leaves and stalks of many weeds. Such crops as clover, buckwheat, and flax should not be sprayed. The spray kills back the tops and keeps the weeds from seeding. Mustard may be sprayed when the most advanced plants are in bud.

A great many chemical sprays have been used with success, such as common salt, using 125 lbs. to the barrel of 50 gallons, or copper sulphate 12 pounds, calcium cyanamide 80 lbs. per acre; sulphuric acid 6, 8 or 10% strength, 107 gallons per acre; or the poisonous sodium arsenite at the rate of 1½ lbs. per acre; The spray of sodium arsenite must not be inhaled. The question is still an open one whether dandelions in lawns can be controlled by spraying (13), (22), (20, 289). Spraying every three to five weeks kills the dandelion tops, but is very hard on the grass too. Spraying may be used successfully on paths, roadways and public squares. It should be noted that iron sulphate stains concrete sidewalks. When the harvest is completed the ground should be plowed and harrowed as soon as possible. This will

start a great many weed seeds germinating; these may be harrowed down or will be killed by frost.

The biennial and annual weeds are controlled in practically similar ways. A biennial stores up strength, the first year, and flowers the next. Often no stems show the first season, as in burdock, wild carrot, blue-bur, and wild parsnip, and only a rosette or circle of leaves at the ground shows. Cut biennials off below the bud in the fall of their first year, or keep mown. These sometimes, however, live on for three or more years, if not allowed to flower. In general, the control means as regards seeds and seedlings is just that for annuals.

Perennial Weeds

More menacing to the grain grower and stock farmer in particular are the perennial weeds. Spreading by seeds and by root stocks, roots, or trailing stems, they live on from year to year, spread rapidly, and resist any but the most persistent and well-planned treatment. Included here are the field sow-thistle, Canada thistle, the paintbrush, field bindweed or convolvulus, the dandelion and the plantains, In the West, sow-thistle has called forth special efforts of government and farmers to fight it. Grain fields have to be fallowed for one or two seasons, and steady cultivation kept up. The great point is to prevent the entrance of the weed by seed or roots carried by implements or waggons. The appearance of perennial weeds should be regarded as a challenge, to be at once accepted. At all events perennials must not be allowed to go to seed. If this is done the roots will spread slowly, and may be starved out by cultivating and cutting off all green growth.

Perennials in pastures, such as paintbrush and dandelion, may be kept down and killed by sheep. Thistles will only be eaten, however, if food is scarce. A success has been made of the use of pigs for rooting up bindweed (convolvulus), where the pigs were in a confined space, but this weed "can be eradicated by clean cultivation if thorough and persistent. (9). The case requires going over the land once every week or ten days." In California "orchardists use the weed knife, which runs under the surface of the soil at a depth of from 3 to 6 inches." (9). The knives are attached to a rig like the two-horse corn cultivator, or the knives may be carried on a drag beam 8 to 12 feet wide. The knives are all inclined inward. It is hard to use in cloddy soil, however. Following cultivation, smother crops may be planted; particularly are "alfalfa, buckwheat, soy-beans and millet" commonly used (11). The Ontario Agricultural and Experimental Union

reports that "the experiments have demonstrated in part that rape as a crop could be successfully used in the destruction of perennial sow-thistle, and couch or quack grass." Smothering small patches of weeds with building or tar paper has been successful, while manure, straw, or old bags have all been found useful.

In conclusion, it should be remembered that "larger crops mean fewer weeds." Increasing the fertility of the soil means heavier crops, better able to smother out weeds. Pasture left down too long, or overgrazed, becomes weakened, and admits weeds. Certain weeds allow the use of, or require special methods to control them in order to reduce the work. Special implements may be used, correct rotations applied. It should be noted that if weeds are kept from going to seed, and clean seed sown, while "perennial weeds are kept from making top growth," all the principles necessary to control our weeds are employed. "Eternal vigilance is the price of safety."

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INSECT PESTS OF CEREAL CROPS OF QUEBEC

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The Province of Quebec does not suffer to the same extent as some of the other provinces from the attacks of cereal insect pests. The reason is possibly the practical absence of fall wheat and the relatively small acreage of spring wheat in Quebec, for it is well known that wheat crops are the chief sufferers from attacks of Hessian Fly, Wheat Midge, Wheat-stem Maggot, Joint Worm and Frit Fly.

From records we learn that the Hessian Fly was destructive in 1805, 1816, 1846-1857, 1877-1884, 1899-1902, and 1913-1915; and that the Wheat Midge was destructive in West Vermont and presumably also in Quebec, in 1820, 1828-1836, 1852-1855-56. It was probably the destructive agent about 1878, but it should be borne in mind that as a rule farmers are not good reporters in cases of minute insects like the Wheat Midge, Hessian Fly and others of a similar nature. They are liable to guess at the cause of the injury.

Dr. Fitch, Entomologist of New York State, called attention about 1854 to the relation existing between weather conditions and insect pests. He pointed out that insect scourges occurred during hot dry seasons. Later observations go to show that sometimes this correlation does occur, but the principle does not seem to apply to all kinds of pests. Army Worm visitation is generally preceded by one or two dry seasons; chinch bugs in the Central States appear in destructive numbers after dry hot seasons; and, as Dr. Fitch observes, the worst year of the Wheat Midge, 1854, was one of unparalleled drought.

Dr. Forbes, of Illinois, says that "a wet season—if not too wet— is a favorable one, and a dry season an unfavorable one," inasmuch as the condition tends to the increase in growth and food-supply to the plant. Most serious insect injuries to growing crops diminish with wet weather and increase with dry. In very wet weather "the sap of the plant may become so dilute, through excessive absorption of water by the roots that it loses its nutritive value, and insects dependent on it are not so well nourished as by the denser sap of a plant growing in a drier soil. They consequently grow less thrifty and multiply less abundantly, and may even diminish rapidly in numbers during a wet season, while if the weather were dry and their food nourishing they would increase steadily at a geometrical ratio. After a year or two or three of drouth the intelligent farmer will be

more watchful for the first appearance of insect outbreak than after a series of unusually wet years."

General Methods of Control.

The various methods of control of injurious insects may be grouped into two general classes: A. *Cultural* or *Preventive Methods*—those practices of culture or of handling the crop that prevent, or interfere with, the development of injurious insects; and B. *Artificial* or *Remedial Methods*—those which deal with injurious insects when they appear by the use of poisonous or contact substances, or other artificial means.

Cultural or Preventive Methods.

For most farm crops Cultural Methods are the only practicable methods. They are essentially Preventives. The most important cultural methods are the following:

1. *Rotation of Crops.*—The growing of crops year after year on the same land permits many insects which feed on the roots to develop and multiply. On the other hand, a good crop rotation makes it impossible, or very difficult, for an insect to pass through its life stages without being seriously disturbed and its food supply destroyed.

(*a*) Some rotations are preferable to others when wireworms and white grubs are abundant. For example, where corn is the chief crop a rotation of clover, corn, oats is better than forage grasses, corn, oats. Professor Forbes, of Illinois, advises plowing the grass in early fall, and sowing clover either with barley, wheat, or rye. The clover is allowed to stand two years and is followed by corn or roots. Certain crops such as clover, barley, wheat and rye, are not so liable to attack as are corn, potatoes, mangels, oats; they are better adapted to follow sod.

(*b*) Moreover, if sod infested with white grubs is broken up early, sown to turnips or rape, and pastured with hogs in late summer and autumn most of the white grubs will be destroyed by the hogs. As the grubs burrow deeply at the approach of cold weather it is not advisable to pasture hogs late in the season. Clover is seldom attacked by white grubs, and hence, is useful as a "starvation" crop before planting to corn, potatoes or mangels.

(*c*) Where the Clover-Root Borer is injurious in second year clover fields, plow up the sod after the first season.

2. *Good Cultivation.*—This involves careful treatment of the soil, the crop, and its products. (*a.*) It means careful attention to the waste pro-

ducts and the waste places which are breeding places for many injurious insects. (*b.*) It means the adoption of deep, late fall plowing under certain conditions, which practice is one of the best methods of dealing with wireworms, white grubs, cutworms and grasshoppers. (*c.*) It means high fertility of soil, and good drainage of the land so that vigorous healthy plants, capable of resisting the drains of insect attacks, are grown instead of poorly nourished plants which are more likely to succumb.

Timely plowing, planting, and harvesting are often effective against some of the worst insects of the farm. For example, two or three fall plowings destroy large numbers of maturing wireworms and white grubs; early plowing of grass in August destroys the eggs and larvae of cutworms and grasshoppers. Late sowing of fall wheat prevents Hessian Fly injury; and early cutting of the first crop of clover destroys the first brood of the Clover Seed Midge, and thus saves the clover seed of the later crop.

The destruction of rubbish, screenings, stubble, dead stalks and weeds deprives many hibernating insects of resting or breeding places. Such insects are Hessian Fly "flax seed," Chinch Bug, Clover Hay Worm, Tarnished Plant Bug, Squash Bug, Stalk Borers, etc.

Cutworms endeavor to lay their eggs in August-September on weeds and grasses. If the land is kept free from weeds and the grass is fed or mown few cut-worms will appear the following spring.

The application of fertilizers is often advantageous in forcing the growth of plants that are attacked, and in repelling insects. Kainit, nitrate of potash, barnyard manure, wood-ashes, and tobacco dust are said to be effective.

3. *Co-operative Measures.*—Co-operation among the farmers of a district is required for the successful control of certain insects such as the Hessian Fly, the Pee Weevil, the Codling Moth, the San José Scale, the Plum Curculio, the Apple Maggot, Grasshoppers and many others.

4. *Natural Enemies of Insects.*—(*a.*) Farmers and fruit-growers can do much to encourage the presence of insectivorous birds among the crops. These birds are most important in keeping injurious insects under control.

(*b.*) Frequently, too, hogs and poultry can be utilized to advantage in destroying white grubs, cutworms, grasshoppers, asparagus beetles, etc., in infested fields.

(*c.*) Lady-bird beetles, ground beetles, and other predaceous insects should be protected as far as possible.

Injurious Insects

The insects that affect farm crops may be classified into (1) those that are periodically injurious, and (2) those that are always present and do more or less damage every year. In the first class can be placed the Hessian Fly, the Wheat-stem Maggot, the Joint Worm, Grasshoppers and Army Worm, Western Wheat Stem Saw-fly; and in the second class, Wireworms, White Grubs, Cutworms and Plant Lice.

The Hessian fly, *Mayetiola destructor* (Say). Healthy wheat stock at left and infested stock at right; *a*, egg; *b*, larva; *c*, puparium or "flaxseed"; *d*, pupa exposed; *e*, adult female laying eggs; *f*, female; *g*, male; *h*, puparia or "flaxseed" in natural position between leaves and stalk; *i*, parasite (*Merisus destructor*). (Slightly enlarged, excepting *e*, which is smaller than natural). (After Riley, Burgess and Forbes).

Hessian Fly.

This insect periodically occasions great losses to wheat, rye and barley. In fall wheat regions there are two generations each year. The adult insect is a small, dusky, two-winged fly about half the size of a mosquito. The eggs are laid on the upper surface of the leaves, in the case of the fall brood the second week in May, and in the case of the spring brood about the first week in September in Ontario. The maggots on hatching move down the leaf and soon imbed themselves at the joints of the stem near the ground and injure the plants, often completely killing them. They appear as brown, oval objects, resembling "flax-seeds," and it is in the flax-seed condition that they winter.

The best preventive measures are (a) late sowing, (b) thorough preparation of the land; (c) trap crops; (d) burning or plowing under infested stubble when practicable; (f) co-operation among the farmers. Sow as late as local conditions will permit, in a good seed bed, and get the neighbors to do the same.

The wheat joint worm (*Isosoma tritici*)—Adult fly, much enlarged. (Reduced from Howard).

Joint Worms.

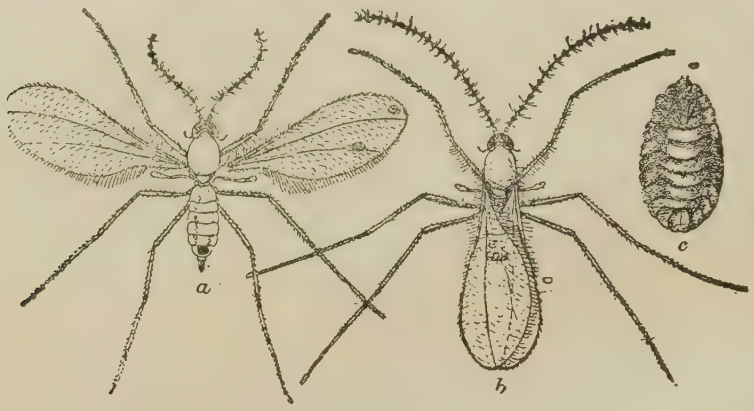
Two species of Joint Worms damage wheat—one producing knots or swellings on the stems, single brooded and confined chiefly to the East; the other chiefly in the West, double-brooded and producing but slight swellings on the stems. Both species are often very injurious, especially to spring wheat. The adults are minute four-winged flies.

The best control measures are (a) rotation of crops; (b) burning and plowing under of stubble when practicable, or harrowing stubble in the spring and collecting with horse-rake and burning; (c) preparation of good seed bed.

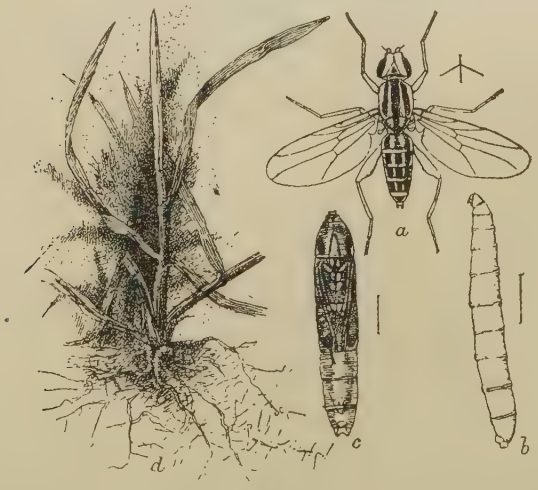
Wheat Stem Maggot or Wheat Bulb Worm.

This insect produces a form of the well known "silver top" or "white-head" disease of wheat, rye and barley, timothy and other grasses. There are probably three broods in a year, the adults appearing in May, July and September. It winters as a maggot in the young plants.

This insect is difficult to control. The following measures have been found of value: (a) grain stacked or threshed and the straw stacked or burned; (b) burning of the stubble.



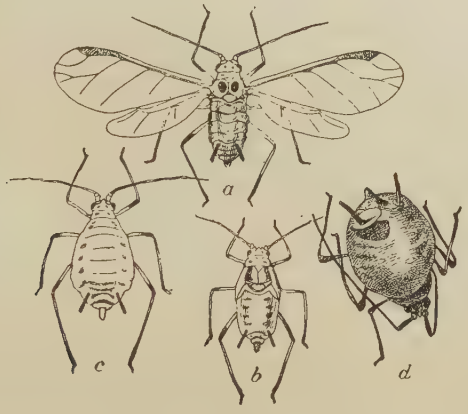
Wheat Midge (Diplosis tritici)—*a*, female fly; *b*, male fly; *c*, ventral view of larva. (After Marlatt).



Wheat bulb-worm (*Meromyza americana*)—*a*, mature fly; *b*, larva; *c*, puparium; *d*, infested wheat stem—all enlarged except *d*. (After Marlatt).

Grasshoppers or Locusts.

These are well known insects, and occasionally do much damage. The chief injurious species are the Rocky Mountain Locust and the Lesser Migratory Locust in the West, the Lesser Migratory Locust, the Clear Winged Locust, the Differential Locust, and the Red-legged grasshopper in the East. The eggs are laid in pod-like masses, usually in uncultivated ground; the young appear in the spring and mature in July, August and September. Grasshoppers are destroyed in large numbers by fungous disease, by mites, by parasitic flies, by the grubs of blister-beetles, and by birds.



Wheat plant-louse (*Nectarophora cerealis*); *a*, winged migrant; *b*, nymph of winged migrant; *c*, wingless parthenogenetic female; *d*, wingless female, showing exit hole of parasite—all enlarged (adapted from Riley).

Grasshoppers may be controlled (a) by scattering broadcast thinly over infested fields in early morning a poisoned bran bait composed as follows: bran, 20 lbs.; Paris green or white arsenic, 1 lb.; molasses, 2 qts.; oranges or lemons, 3 fruits; water, 3 1-2 gals. The bran and Paris green, or white arsenic, are mixed thoroughly dry; the juices of the oranges or lemons are squeezed into the water and the pulp and peel, cut into bits, added; the molasses is then added, and the liquid poured on to the poisoned bran which is then thoroughly stirred. The amount given above is sufficient for five acres. Excellent results will follow after two to four days. (b) By fall plowing of sod land.

Plant Lice.

Several species of plant-lice are to be found on cereal crops. They collect on the leaves and heads and suck the juices from the plant, causing

them to turn yellow and sometimes to shrivel. They multiply very rapidly, but are usually, partially at least, held in check by lady beetles, and other insects.

Army-worms.

Army-worms are the caterpillars of "miller" moths, and are very closely related to the common cutworms.

There are usually two broods of the Army-worm each season. The winter is passed as half-grown caterpillars which mature in May, and the adult moths appear early in June to lay eggs on grass leaves for the second or summer brood of caterpillars which reach maturity in July and which often do much injury. The caterpillars or worms usually feed at night, consequently fields may be ruined before their presence is known. Moths emerge in August, and again in October. The following diagram shows the chief points in the life-history of the Army-worm. Since the female moth lays about 700 eggs it is easy to see how rapidly the numbers increase, and the necessity for migration from field to field to get food.

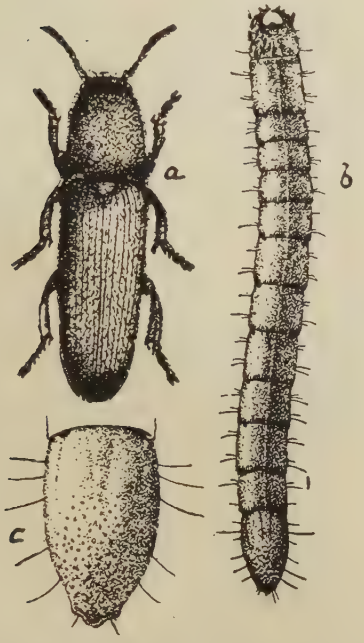
Serious Army-worm invasions occurred in Ontario and Quebec in 1895 and in 1914, and from a study of the climatic conditions of these years it would appear that they are more abundant in a wet spring or summer following a dry season.

Army-worms may be controlled by (a) plowing three or four furrows in front of the advancing army and killing the worms that fall into the furrows; (b) poisoning a strip a few yards wide on the threatened side with the poisoned bran mash, such as is used against the grasshoppers, and (c) plowing the fields in late fall.

Wireworms.

Wireworms are the grubs or beetles known as click beetles or "skip-jacks." They are slender, yellowish, wire-like grubs, 1-2 to 1 inch long, mostly vegetable feeders and living in the ground. There are several species of wireworms, but they have very similar life-histories. In general the beetles emerge from the ground in May and lay their eggs in grass land, on or close to the crown of the roots. The young grubs feed and grow all summer, and do not mature until July and August of the third year. Then they change to pupae, and a month later into beetles, but the latter do not appear until the following May.

Wireworms develop mainly in sod land and require practically two years to complete their life. The following preventive measures are valuable:

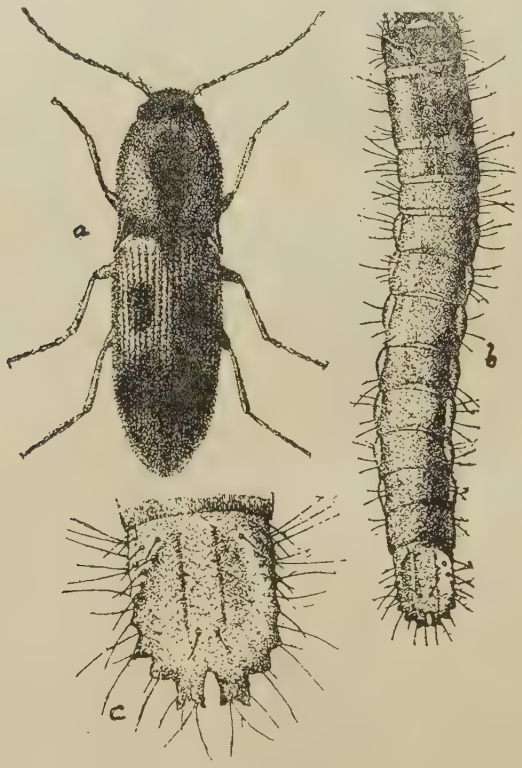


Melanotus cribulosus: The Corn Wireworm—*a* adult beetle; *b* wireworm or larva; *c* last segment of larva.

Agriotes mancus (Wheat Wireworm)—*a* adult beetle; *b* wireworm or larva; *c* last segment of larva.

(a) fall plowing of sod land twice; (b) a special rotation of crops, bearing in mind the fact that clover, barley, wheat and rye are not so liable to attack as corn, potatoes, mangels and oats.

All attempts to poison wireworms in the soil have been futile; moreover, no farm crop is immune from their attacks, although many farmers claim that buckwheat, mustard and rape are not attacked.



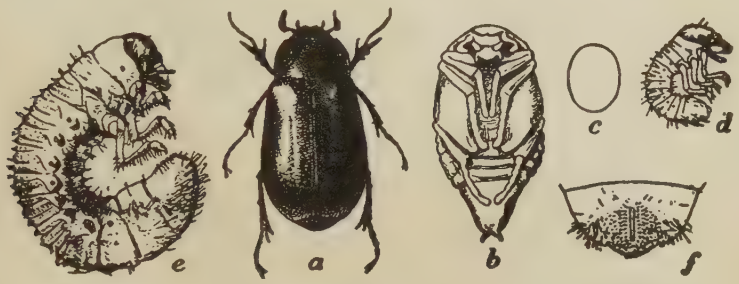
Drasterius elegans; *a*, adult beetle; *b*, wireworm or larva; *c*, last segment of larva.

White-Grubs.

These are the grubs of June beetles which are common in May and June about lights at night. Their large size, white body, brown head, enlarged hinder portion of abdomen and the curled-up attitude of the body distinguish them from other grubs that occur in the soil. They feed on the roots of all kinds of grasses, cereal crops, corn, potatoes and root crops generally. They also injure strawberries, fruit trees and shade trees.

The beetles appear in May and June and lay their eggs below the surface of the ground, usually near the roots of grasses. The grubs live for over two years in the soil. Grubs hatched in June, 1910, change to pupae in July, 1912, and emerge as beetles in May and June, 1913.

Biological facts of importance have been obtained in recent years (see Bulletins 116, 186 and 187, Illinois Agricultural Experiment Station, and



Lachnosterna arcuata—*a*, adult beetle; *b*, pupa; *c*, egg; *d*, newly hatched larva; *e*, mature larva; *f*, last segment of larva.

Farmers' Bulletin 543, U. S. Department of Agriculture) regarding the habits of white grubs, which may be summarized as follows:—

(a) Some species have a life-cycle of two years, but most have a cycle of three or four years.

(b) The life-cycle tends to lengthen northward.

(c) The adult beetles feed on the leaves of oak, ash, elm, poplar, willow, maple, hackberry, plum and apple, during the night and migrate to the soil in early morning. Mating occurs at night. They have been observed feeding on corn and grass.

(d) The eggs are generally deposited in the high grounds covered by vegetation near wood lands.

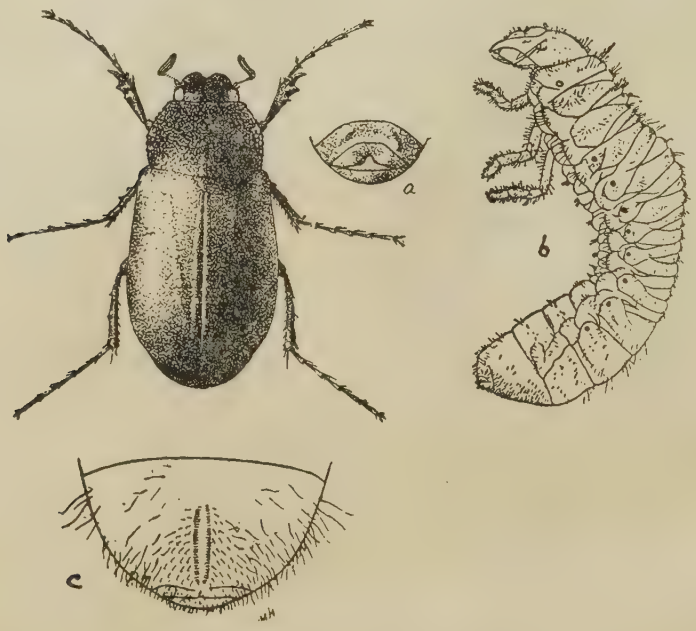
(e) Clover, alfalfa and buckwheat are not injured, and small grains are not so much injured as are corn, timothy, strawberries and potatoes.

(f) As the grubs change to pupae about the end of July, disking infested land as soon after that date as practicable destroys large numbers of the tender pupae and adults in the ground.

(g) Where grubs are small (first year) or large (second year) plowing up to 1st October destroys large numbers.

(h) White grubs are most abundant in the neighborhood of trees.

(i) The adult beetles prefer to lay their eggs on (1) pastures; (2) small grains; (3) fallow land grown up to weeds; (4) clover and corn; (5) meadow crops (Forbes).



Lachnosterna rugosa—*a*, June-bug, adult; *b*, June-bug or white grub larva; *c*, last segment of white grub and larva.

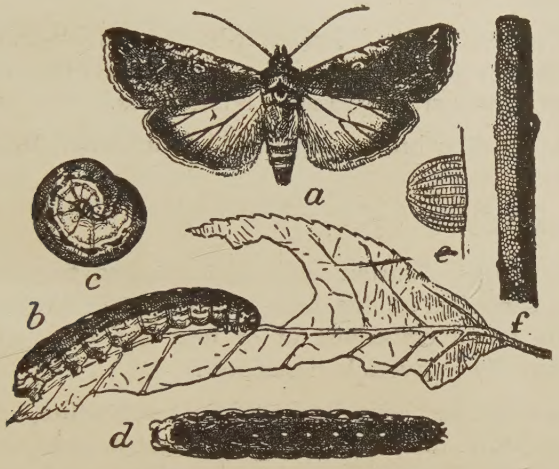
Regarding methods of control, as with wire-worms, remedial methods are difficult and unsatisfactory. (a) A short rotation in which clover follows grass or is grown at short intervals will prevent the increa e of these insect:. Small grains should follow clover before corn or potatoes. (b) Fall plowing of infested sod. (c) Hogs and poultry will kill large numbers of white grubs, when allowed access to the field being plowed. (d) The adult June beetles can be trapped in large numbers by lanterns set in a basin of water or diluted kerosene.

Cutworms.

These are the caterpillars of "miller" moths which are common visitors of lights in August. They are night-feeders and are essentially grass and clover insects, and by far the greater number are bred in pastures and meadows. There are many species, some of which, however, cut off young corn, mangels, cabbages, turnips and tomatoes.

The majority of the cutworms winter as partly-grown caterpillars and pupate in the ground in late June and early July. The moths emerge in early August and lay their eggs in grass lands. The caterpillars that hatch from these eggs feed on the roots of grasses until winter sets in.

Cutworms are then most destructive in May and June. They lie hidden in the daytime in the ground close to the plants attacked, but at night they come to the surface to feed and "cut off" the young plants close to the ground.



A cutworm—showing various stages.

Cutworms are readily controlled by (a) a poisoned bait such as is used against army worms and grasshoppers; (b) deep plowing of grass lands in autumn destroys many eggs and young cutworms; (c) protecting cabbages, tomatoes, etc., by a collar of tin around the stem.

"White Head" Disease of Cereals and Grasses.

It is often observed in a field of oats or other cereals that many of the heads are white, and on examination it is found that these heads have not filled out. This "white head" condition, sometimes called "silver top," is produced by several agents, to some of which reference has already been made. The Wheat Stem Maggot and the American Frit Fly are largely responsible in the case of wheat heads and timothy, and in other cases where oats are concerned the cause is a minute, sucking, yellowish-brown insect called the "grass thrips." This insect lays its eggs in spring and the young forms become full grown in about two weeks. It is likely that there are several broods of this insect and that it is able to reproduce in much the same way as plant lice. At present no remedy is available.

Host Key to Insects Injurious to Cereal Crops

Roots.

(a) Plants stunted, yellow, and withered or dead; roots eaten.

(1) Smooth, slender, wire-like, 6-legged worms present in the soil. *Wireworms.*

(2) Present in the soil large soft-bodied whitish grubs, with brown heads, and hinder portion of body thicker than fore end. When disturbed grubs curl up. *White Grubs.*

(3) Large dirty brown maggots, ½-1 inch long. *Meadow Maggots.*

Stems and Leaves.

(a) Young plants dwarfed, and color changed to yellow or brown; stems shrivelled at the base, often bent or broken off, flaxseed objects found embedded at or near the base. Oats immune. *Hessian Fly* (Mayetiola destructor.)

(b) Stems above last joint dead, and the heads white,—"silver top" or "white head" disease. Greenish maggot in stem above last joint. *Wheat Stem Maggot* (Meromyza Americana) and *American Frit-fly* (Oscinis carbonaria).

(c) Swellings or galls on the joints, and the stems bent or broken before harvest. *Joint Worm* (Isosoma tritici).

(d) Stems broken down and tunnelled, blackish near the joints; heads turning white; presence in tunnel of yellowish-white grub of saw-fly; oats immune. *Western Wheat-stem Saw-fly* (Cephus occidentalis).

(e) Leaves sickly and whitish; the presence of small red and larger black and white bugs. *Chinch Bug* (Blissus leucopterus).

(f) Stems and leaves sickly; the presence of many green plant lice. *Wheat Plant Louse* (Aphis avenae).

(g) Stems and leaves eaten by large dingy striped caterpillars. *Army-worm* (Leucania unipuncta).

(h) Leaves eaten by locusts or grasshoppers. *Red-legged and other Grasshoppers.* (Melanoplus femur-rubrum et al).

Heads.

(a) Heads turn white and grains are shrivelled or imperfectly filled. *Wheat Stem Maggot* (Meromyza Americana) and *American Frit-fly* (Oscinis carbonaria).

(b) Heads shrivelled and blighted, and imperfectly filled, and the presence of orange colored maggots. *Wheat Midge* (Diplosis tritici).

(c) Heads covered with green plant lice. *Grain Louse* (Aphis avenae).

(d) Heads turn white; minute dots or lines on leaves usually running parallel with the veins and remaining white; the work of minute insects. *Grass Thrips* (Anaphothrips striatus).

(e) Spotting of the leaves, spots whitish at first, turning brown or black. *Six-spotted Leaf-hopper*, Cicadula 6-notata.

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